PB-230 323

FISH KILL INVESTIGATION SEMINAR HELD ON JANUARY 12-14, 1971. COLLECTION OF PAPERS

Environmental Protection Agency
Cincinnati, Ohio

April 1971

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 230 323

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FOREWORD

The frequency of pollution caused fish kills appears to be increasing and certainly the awareness of the public to these incidents is prevalent. Our expanding society has produced an increase in the complexities of toxicants which is no doubt contributing to the increase of fish kills. Public awareness has increased the demand for prompt actions concerning fish kill. Because of these factors, the State and Federal agencies are attempting to improve their abilities and knowledge of the proper handling of a complex and often frustrating problem.

Therefore, the Water Quality Office, Environmental Protection Agency and the Ohio Cooperative Fishery Unit, Ohio State University, cosponsored a seminar dealing with fish kill investigations. Governmental agencies from the Ohio River basin States participated in the program.

The purpose of the seminar was to disseminate and exchange knowledge and ideas concerning several phases of a fish kill investigation.

In this manual we have attempted to select high points and abstracts of the program. In many cases, due to limitations, we were unable to include the complete presentation. If you desire such material, we hope the authors will be able to provide it.

It should be mentioned that to our knowledge this effort was the first such attempt to conduct a seminar on this subject and it is hoped that further similar efforts are attempted in other regional locations. Perhaps with further refinements and new materials, a national manual may evolve from such effort.

INTRODUCTION

by

Ronald Preston, Program Coordinator

INTRODUCTION

Although fish kills can result from natural causes, many such mortalities may indicate degraded water quality. Prompt and well executed investigations can be a valuable tool for determining causes of the kill as well as leading to improvement of chronic water quality problems. Because of the regulatory value to governmental agencies and the impact on the public, the need for a carefully planned, properly conducted, and legally defended fish kill investigation is in demand.

A fish kill investigation can be one of the most complex procedures encountered by a water pollution control agency. This complexity leads to the need of employing a host of disciplines in order to arrive at an acceptable and defensible explanation of the cause of a kill. The interaction of the team effort can add to the complexity of the problem.

Add in the ingredients of the demand for prompt results, the limited opportunity for obtaining proper information, the high degree of variability, the unknowns, and a fish kill investigation can become a perplexing and frustrating task.

It is recognized that a properly conducted fish kill investigation involves a team effort. In the final analyses, administrators, fishery scientists, chemists, law officers, parasitologists, histologists, sanitary engineers, technicians, and attorneys all play an important part in producing results.

In this seminar, then, we attempted to bring together the diciplines that may be involved in a fish kill and relate to each other the why, what, where and when of their particular chore.

There was an attempt to arrange the program into related subject phases such as administrative, legal, analytical, damage evaluation, and natural versus pollution caused fish kills. Finally, case histories which called for the best abilities and facilities available were presented as examples of the need for a well planned multi-disciplined approach.

STATE OF THE ART

by

Kenneth Mackenthun

A PREFACE FOR THE INVESTIGATION OF FISH KILLS

Kenneth M. Mackenthun
Acting Director
Division of Technical Support
Water Quality Office
Environmental Protection Agency

Since the beginning of water pollution investigations, floating dead fish have been a red flag to the observer that something is not right with the aquatic environment. Early in legislative history for water pollution control, many States adopted particular laws to assess damages from those who, through the introduction of foreign materials, would render the States' waterways toxic to fish and other aquatic life. Fish kills have been the subject of litigation in the courts and many times have served a useful purpose to stimulate and focus public concern and attention towards appropriate water pollution control.

The Federal government began a voluntary annual census of fish kills in June 1960. These pollution caused fish kills are reported through appropriate State officials to the Federal water pollution control authority (now the Water Quality Office within the Environmental Protection Agency) where the data are tabulated and analyzed. Since 1960 over 144 million fish have been reported killed in 4,200 incidents.

In 1969 alone an estimated 41,000,000 fish were reported killed in 45 States by identifiable pollution sources. Of the number of reports, industrial operations ranked first as a killer of fish, followed by

agricultural, municipal, transportation and other operations in that order. As expected, the months of May through September ranked highest with the number of reported fish kills. August was the highest month with number of reports and December was the least. Indicative as these annual summaries are, there remained an urgent need to determine the specific cause of a particular kill so that the cause could be corrected and water quality enhanced in the future.

In a news release dated August 21, 1969, Commissioner Dominick of the Federal Water Pollution Control Administration said that the present voluntary program of reporting fish kills is no longer adequate in our stepped up overall campaign against water pollution. The old system did not provide for immediate reporting of fish kills incidents and did not require any counter action by the FWPCA. Because fish kills indicate a violation of water quality standards or enforcement conference recommendations, it is particularly important that any sizable fish kill be reported and scientifically investigated. The Commissioner directed each Regional Director to take an active role in investigating fish kills, in determining their cause, in providing technical assistance on any immediate control measures or warnings that can be taken and in providing technical or other authorized assistance in designing control measures that would prevent a recurrence of the kill. Under this plan the Regional Offices of the FWPCA were to establish procedures with State water pollution control agencies to insure that they

receive immediate reports of significant fish kills within each region. It is recognized that the primary responsibility for the investigation of fish kills rests with the States as is the case in all water pollution control matters. The Water Quality Office of EPA shares these responsibilities in interstate waters or in waters where there are Federal-State enforcement actions. The proper investigation of a fish mortality is through a State-Federal partnership. The role of the Federal government is to offer technical assistance to the State in the investigation of kills to the extent that resources permit. In areas of Federal jurisdiction we are prepared to initiate independent action to achieve a swift and adequate determination of the cause of a kill and of the appropriate control and preventative measures if such action becomes necessary. Fish kill coordinators have been identified for each of our regional offices and in Headquarters. The coordinators are in a position to respond to requests for technical assistance from the States in any aspect of the fish kill investigation and to receive the immediate reports from the States on significant fish mortalities.

Obviously each fish death can not be investigated fully. Only significant fish kills should be reported. The definition of significance is a matter of judgment, but it should include mortalities that are important because of sport or commercial fish values, that result from a suspected negligent discharge or malfunction of a waste treatment device, or that show widespread environmental damage.

The immediate report received by the region and supplied by the State should include sufficient pertinent information to identify the fish kill area, the relative extent of the mortality, the kinds of fish involved, whether or not technical assistance to investigate the cause has been requested, and who should be contacted to obtain additional information. This information is then transmitted to Headquarters by the Regions.

Follow up information developed in fish kill response investigations or otherwise acquired should be sent to the Regional coordinators and in turn to Headquarters of the Water Quality Office, as soon as possible. We are particularly interested in information concerning the cause of the kill and actions to alleviate the cause, to collect damages, and to prevent future incidents. To make this fish kill investigative partnership effective, we need to receive information on fish mortalities immediately, by telephone.

Recently we evaluated our records relating to the program of reporting and responding to significant fish kills. In this evaluation we choose a fisherman year - that period of time from September 1, 1969 to October 1, 1970. At the onset I will say that our efforts have not been enough and they must be improved. In this period of time 231 fish kills were reported to my office under this program. These reports accounted for approximately 50,000,000 fish; and 860 miles of stream and 10,700 acres of other waters were affected. Of the 231 reported incidents, 194 were investigated in some fashion. The

States investigated 170 incidents and the Federal government assisted the States in their investigation of 21 incidents. There is some indication in the record that the States have requested and received more assistance from the Federal government in the investigation of fish kills during the latter half of our fisherman's year than during the first half. We hope that as this program matures and develops that assistance from the Federal government will be requested in a much greater number of investigations and that we will be able to provide the type of assistance that will be meaningful and definitive in determining the cause of fish deaths.

Initial laboratory support for the investigation of fish mortalities should come from any Water Quality Office laboratory within the Region where the mortality occurs. If this support is unable to respond to the needs of a particular investigation, additional special services canbe obtained from the Analytical Quality Control Laboratory in Cincinnati, Ohio, the National Water Quality Laboratory in Duluth, Minnesota, and the Southeast Water Laboratory at Athens, Georgia. Analytical capabilities in pesticides and other organics, heavy and trace metals, oil identification, complex organic compounds and certain fish diseases and bioassay analyses are available at these laboratories.

The Bureau of Sport Fisheries and Wildlife maintains a small staff of disease specialists within the Division of Fish Hatcheries to provide diagnostic services to national fish hatcheries. As time

permits, these hatchery biologists are available to assist other agencies in diagnosing fish diseases. Emergency inquiries for assistance may be directed to the nearest hatchery biologist. Such hatcheries are located in the States of Washington, California, Montana, Utah, Arkansas, Wisconsin, North Carolina, West Virginia, and Maine. In addition, there are two Bureau research laboratories that specialize in fish diseases. The Eastern Fish Disease Laboratory, Kearneysville, West Virginia 25430 serves the area east of the Mississippi River, and the Western Fish Disease Laboratory, Building 204, Sand Point Naval Air Station, Seattle, Washington 98115 serves the Western States. Except in emergency situations, requests for fish disease diagnostic services should be directed through Headquarters of the Water Quality Office.

As far as the art and science of fish kill investigations are concerned, one might say with truth that we are entering the age of the Renaissance. Historically we have advanced slowly and sometimes it seems but little since the days of Shelford, Richardson, Forbes, Juday, and Birge.

One of the greatest deterrents to the conclusive investigation of fish mortalities is our seeming inability to arrive at the scene soon enough. Speed is all important in the initial phases of any fish kill investigation. Early arrival at the scene, after a fish kill begins, usually determines the success of the investigator's evaluation of the problem. Observations of the actions of moribund

fish, and the collection of appropriate samples at this time, are often a vital link to the arrival at a conclusive determination of the cause of death. Dead fish disintegrate rapidly, especially in hot weather and the cause of death may disappear or become unidentifiable within minutes. Thus, the system of early warning followed by speedy investigation is essential to a successful fish kill investigative program.

The degree of success of an investigation will depend to a large extent on the investigative preparedness of the party involved. Planning is an essential component of any successful enterprise and the successful investigation of fish mortalities is not an exception. Planning will decrease the interval of time between notification and arrival at the scene. Appropriate planning will insure the availability of proper equipment and testing facilities and it will decrease the confusion and uncertainty that sometimes is associated with the analyses of collected samples. Planning will identify specific laboratory capabilities before the need for these occur. Planning will alert reserve resources should these be required by a particular incident.

The investigator should be ever mindful of the potential legal aspects of his investigation. The investigation should be conducted to insure that collected data will be acceptable to the courts and will withstand critical cross examination. Samples collected in the field and transported to a laboratory should be sealed and so identified

by the sender that the chain of evidence always remains intact, and that it cannot be broken by opposing attorneys. When the samples are received in the laboratory they should be associated with a continuous log that records the date and exact time of each step in the analytical procedures and the person responsible for the samples during that step. When not in use, samples should be retained in a locked room. As an effective tool of the water pollution control program, the evidence collected by the investigator must withstand the scrutiny of the courts. Preparation of the investigative data in this manner will be an asset even though remedial actions and pollution abatement procedures are arrived at through informal negotiations rather than court action.

There are about six essential steps connected with the investigation of a fish mortality. The first is the collection of preliminary information to identify the problem and its extent in very specific terms. There follows three concurrently attacked phases that include physical observations, the collection of chemical data, and the collection of biological samples. Observations by an experienced investigator are invaluable to define the cause of a given kill. Perhaps no single factor is so important. Particularly noteworthy are the general appearance of the water, its color, clarity and whether sparkly or dull and lifeless. The presence of oil, excessive algae, unusual biotic growths such as sewage fungus, excessive amounts of higher aquatic plants and the color and appearance of rocks,

sticks or debris within the water are important considerations. Notes on the actions of fish prior to death are important, as well as observed actions of other organisms such as crayfish and other benthos. Often much can be learned regarding the severity of the kill to the aquatic environment by lifting a rock from the stream bed or a piece of debris from the water and noting the types of organisms that remain alive. The fifth component of an investigation is the analyses of the many collected samples. The last embodies the tabulation and interpretation of data and the preparation of the report. These are all equally important aspects of an investigation and, if it is to be successful, all must be performed with great care.

The collection of chemical and biological samples and data involve a number of technical considerations. The Division of Technical Support of the then Federal Water Pollution Control Administration published a 21 page booklet entitled, "Investigating Fish Mortalities." This publication considers some of the technical aspects of the sample and data collection. It may be obtained from any of our regional offices or in Headquarters. I commend it to your reading.

I. ADMINISTRATIVE ASPECTS

Moderator: Bernard Carter

STATE LEGAL PROBLEMS

by

John Davidson

Topic: State Legal Problems

Presented by John T. Davidson, Assistant Attorney General, State of Ohio at the January 12-14, 1971 Fish Kill Invetigation Seminar sponsored by Environmental Protection Agency and Ohio Cooperative Fishery Unit of The Ohio State University

I think congratulations are in order to the Environmental Protection Agency and the Cooperative Fisheries Unit of Ohio State University for bringing us all under one roof. This type of meeting or gathering is long over due and will, I am certain, be very beneficial for all participants. The sharing of ideas, procedures, and techniques cannot help but improve the "State of the Art." In addition, standardization in at least some areas of our efforts will be forced upon us, if not by the "great white father" in Washington, then inevitably by the pollutors themselves. For example, a pollutor who in one state kills 20 or 30 thousand fish and is asked to pay two or three hundred dollars in damages is going to question, and has questioned, with good reason, the validity of our programs, when he kills approximately the same number of fish in another state and is asked to pay fifteen or twenty thousand dollars in damages.

I would like to thank Mr. Preston and the other members of the program committee who set up this seminar for inviting me to attend and for the opportunity to share some thoughts with you today. Before I get into the assigned topic of discussion I would like, with your permission, to mention a couple of points which I feel should be considered by yourselves and others who have the best interests of our environment at heart.

Though I realize that Attorneys are viewed with a certain amount of totally undeserved suspicion and distrust by members of other professions, such as your own, it is my firm conviction that a cooperative effort, through the courts, by professionals in the environmental and legal fields (this would include the chemist, the biologist, the engineer, the legally trained enforcement investigator, and the attorney) will go a long way toward solving many of the environmental problems we have today. I feel that this can be accomplished, at least in this state, and I suspect in most states represented here, with laws which are presently on the books and in most cases which have been on the books for a number of years.

It is my belief that good and honest enforcement of present laws would, in most cases, be of much greater value to our people and our environment than would the adoption of new environmental legislation, which admittedly, is more attractive to the politicans.

Another matter which I think should not be overlooked is that the unfortunate state of our natural environment today is one problem of society which cannot be blamed on the courts. This is a truism at this juncture simply because the problem has, up to this point, for the most part, not been brought before the courts. To the best of my knowledge the only law in this state related to pollution which has been effectively brought before the courts, out of a large number which have been on the books for a number of years, is the State's Stream Litter Law. In 1968, a relatively small agency in this state (The Ohio Division of Wildlife) received the right to enforce this law - since that time Ohio Wildlife personnel have processed through court approximately 1600 cases - out of this total of 1600 cases only 8 have been lost. This particular law is a criminal statute, carrying with it the burden of proof of beyond a reasonable doubt and all the other formalities which must be observed in a criminal prosecution. I mention this example for two reasons:

First, it proves that a criminal statute dealing with the environmental pollution problem can be effectively enforced, and

Secondly, it proves that the courts are very receptive to and cognizant of our environmental problems. Thus it is my belief that the dominant and controlling problem curtailing effective enforcement of environmental pollution legislation, has been in the past, and is today political rather legal in nature.

One other matter I would like to touch on prior to talking about what I am supposed to talk about - and this I guess could best be described as the power of positive thinking. It is my belief that the state of your art is much more advanced relative to other professions than what you are willing to admit.

The medical profession has for years testified as to the intricacies of the human anatomy with the ferver and certainity of all that is holy and right. Medical doctors often testify with absolute certainity as to the nebulous state of disability from a back injury the diagnosis of which no two doctors can agree upon - yet, the court accepts this testimony, and properly so, because the medical profession knows more about the human anatomy than anyone else.

The fact that diagnosis of the same injury can change through the years as a result of improved techniques and methods does not lessen the value of the testimony as far as the court is concerned. The court is interested in arriving at a just conclusion based upon the best information available. Anyone who can enlighten the court and or the jury will be permitted to do so - naturally this is so within the framework of procedures set up by the courts to insure or attempt to insure that justice is served.

I quote to you a statement from a decision by the Court of Appeals of Cuyahoga County, decided October 22, 1970.

The court stated as follows:

"A witness who has acquired knowledge or skill by experience, observation or practice on a subject with which the lay person is not supposed to be acquainted may give his opinion on it."

The court in this decision goes on to quote a 1967 Ohio Supreme Court decision which stated as follows:

"No one can validly contend that an expert in a particular field that is beyond the experience, knowledge or comprehension of a layman should be silenced where such knowledge is vital to a proper determination of litigation. Rather, this court has continually held that in all proceedings involving matters of a scientific, mechanical, professional, or other like nature, requiring special study, experience or observation not within the knowledge of laymen in general, expert opinion testimony is admissible to aid the court or the jury in arriving at a correct determination of the litigated issue."

Gentleman, what I am attempting to persuade you of is simply this - first your knowledge in the field of pollution and its effects on aquatic life far exceeds that of the laymen and will be welcomed with open arms by the court and secondly, the fact that you possibly cannot testify with absolute certainity that so many parts per million of a particular substance is toxic to a certain species of fish under such and such conditions over a period of so many hours and minutes, and further that a noted colleague of yours does not happen to agree with your opinion, in no way lessens the importance as far as the court is concerned of getting what information you do have before the court and or the jury.

In any discussion of state legal problems it is necessary to first talk about state legal responsibility and in this connection the right of the private citizen should not be overlooked. In this state a private citizen has no legal right to bring an action on behalf of the state to abate or control pollution. Nor do we have a statute similar to the 1899 Rivers and Harbors Act whereby a citizen may bring legal action if the governmental agency with responsibility fails to do so.

However, a private citizen in Ohio may bring a civil action for damages and for injunctive relief when his property or person has been damaged by pollution of one sort or another. In addition, a private citizen may force by proper legal action a state agency or administrator to do that which by law the agency or administrator is required to do. This action is referred to as a mandamus action and has been used fairly frequently in this state - but not in the area of environmental pollution. This remedy is available only when there is a clear legal duty on the part of the state and this duty has not been performed by the state.

This brings us to the question of state legal responsibility - in other words, when a stream pollution and or fish kill is reported what state agencies have what legal responsibilities. I have no knowledge of the breakdown of responsibility in other states but I will attempt to briefly touch on the responsibilities as they exist in Ohio. Perhaps another way of examining the same question is to ask what alternatives are available to the state upon receiving a report of pollution and or a fish kill.

The only governmental agency in the State of Ohio with substantial water pollution abatement power is the Ohio Department of Health. The Ohio Department of Health through its Water Pollution Control Board has been given the responsibility by the Legislature of abating and or controlling pollution. This is accomplished in part through a permit system.

The pertinent state law reads as follows: Pollution is defined as "the placing of any noxious or deleterious substances in any waters of the state or affecting the properties of any waters of the state, in a manner which renders such water harmful or inimical to the public health, or to animal or aquatic life, or to the use of such waters for domestic water supply, or industrial or agricultural purposes, or for recreation." The law continues in pertinent part, "no person shall cause pollution of any waters of the state, or place or cause to be placed any sewage, industrial waste, or other waste in a location where they cause pollution of any waters of the state. Any such action is hereby declared to be a public nuisance, except in such cases where the Water Pollution Control Board has issued a valid and unexpired permit or renewal thereof."

The Water Pollution Control Board has the legal right to institute or cause to be instituted in any court of competent jurisdiction, proceeding to compel compliance.

The State Attorney General, upon the request of the Water Pollution Control Board, has the responsibility to prosecute any person who violates, or who fails to perform any duty imposed by the pertinent sections of law. The relief sought would normally be injunctive in nature, however, the law does provide that each day such violation continues after a conviction for a violation is a separate offense. Also, that the maximum penalty for each violation shall not exceed five hundred dollars and or imprisonment for not more than one year. It is therefore legally possible that a person would be fined up to five hundred dollars per day for as long as the violation continues.

To the best of my knowledge these legal alternatives to bring the problem before the courts have seldom if ever been used by the Water Pollution Control Board.

A more recent addition to the arsenal of weapons entrusted to the Water Pollution Control Board is the responsibility to promulgate and adopt water quality criteria standards. These standards are presently being set up and presumably would be enforced through the Attorney General Office, again at the request of the Water Pollution Control Board.

In addition to these broad powers entrusted to the Water Pollution Control Board, the state has several nuisance statutes which under proper circumstances could be utilized to control or abate pollution. However, most of these sections contain provisions which exempt persons under permit from the Water Pollution Control Board.

These nuisance statutes would normally be enforced by local authorities with county wide jurisdiction and would be processed through court by the county prosecutor.

In addition to these alternatives, various agencies within state government by the very nature of their legal responsibility can at times become involved in pollution problems. Several examples would be the Division of Forestry and Reclamation in the acid mine drainage field, the Division of Oil and Gas in the oil pollution field, possibly the Public Utilities Commission in the pipe line and transportation field. Unquestionably the best example of what a state agency without direct pollution abatement authority can do and is doing in this state is the Ohio Division of Wildlife.

Under Ohio law the ownership of and the title to all wild animals in this state, not legally confined or held by private ownership legally acquired, is in the state, which holds such title in trust for the benefit of all the people. Wild animals are defined by statute as clams or mussels, crayfish, aquatic insects, fish, frogs, turtles, wild birds, and wild quadrupeds. The Division of Wildlife is by statute given the responsibility to enforce by proper legal action or proceedings the laws of the state and its orders for the protection, preservation, propagation, and management of all wild animals in this state.

Based upon this authority the Ohio Division of Wildlife has carried out a very effective pollution and fish kill investigation program with the goal being the collection of damages based upon the value of the wild animals killed plus costs incurred during the field investigation. In addition, if court action is necessary for the collection of damages injunctive relief may be and has been sought in conjunction with payment of actual damages.

The success of this program is reflected in the fact that for the past three years close to 90 percent of all wild animals killed by pollution in this state have been paid for in full by the party responsible.

Although the authority of the Division of Wildlife to carry out this program is based upon statutory law, the legal theory and if necessary the legal action commenced is civil in nature and is based upon the tort liability of the party responsible for killing the wild animals.

Since the legal theory proceeded upon is civil in nature and since the Division of Wildlife by statutory law has sole responsibility for the care, protection, propagation, etc. of wild animals, the fact that the party responsible for killing wild animals by pollution has an effluent permit issued by the Water Pollution Control Board does not prevent or prohibit the Division of Wildlife from proceeding with civil action for damages and injunctive relief where it appears to be warranted.

As I mentioned earlier the Division of Wildlife has also been active in the pollution field through its efforts in enforcing the stream litter law. This approach is criminal rather than civil in nature, conviction resulting in a fine of not less than $25.00 nor more than $500 and or imprisonment for not more than thirty days. This section, although it has been used in situations involving fish kills, has several limitations.

First, those persons under permit from the Water Pollution Control Board are exempted from its provisions.

Secondly, municipal corporations are exempted from its provision as a result of their not being considered persons as the word is defined in said section.

A third and less important reason is that this is a criminal statute carrying with it the burden of proof of beyond a reasonable doubt and other technicalities inherent in criminal prosecution. Finally the civil approach of seeking damages and possible injunctive relief serves as a greater deterrent in most cases than does criminal prosecution.

In conclusion then, it is legally possible in this state for a person who in one instance pollutes waters of this state, which pollution results in a fish kill and which pollution results in property damage to a landowner or owners along the waterway, to be faced in court with charges from three different sources; first, criminal prosecution for violation of the state water pollution control laws; second, civil action for damages and possible injunctive relief instituted by the Ohio Division of Wildlife and based upon the value of the wild animals killed; and third to be faced in court with civil action for damages and possible injunctive relief instituted by any damaged landowner and based upon the value of the damage to the landowner's property.

There is one other aspect of the fish kill pollution program conducted by the Division of Wildlife which I think is worth mentioning, this being that we have found that most responsible industries, municipalities, and individuals when properly confronted with a well prepared investigation and good evidence will settle out of court for full payment. If this can be accomplished it represents a tremendous savings on the part of the state in terms of the time and manpower necessary to properly conduct a full-blown trial as involved and as complicated as cases of this type can be.

Because of time limitations and my belief that we can accomplish more by questions and discussion from the floor we will now entertain and attempt to answer your questions and comments.

It is my hope that if I haven't imparted too much factual material, that I have at least stimulated some thinking. I thank you for your time and for inviting me to share some thoughts with you during the seminar. I am looking forward with great interest to the remainder of the meeting.

JTD/m
1/12/71

GROUP STATE PROGRAMS

by

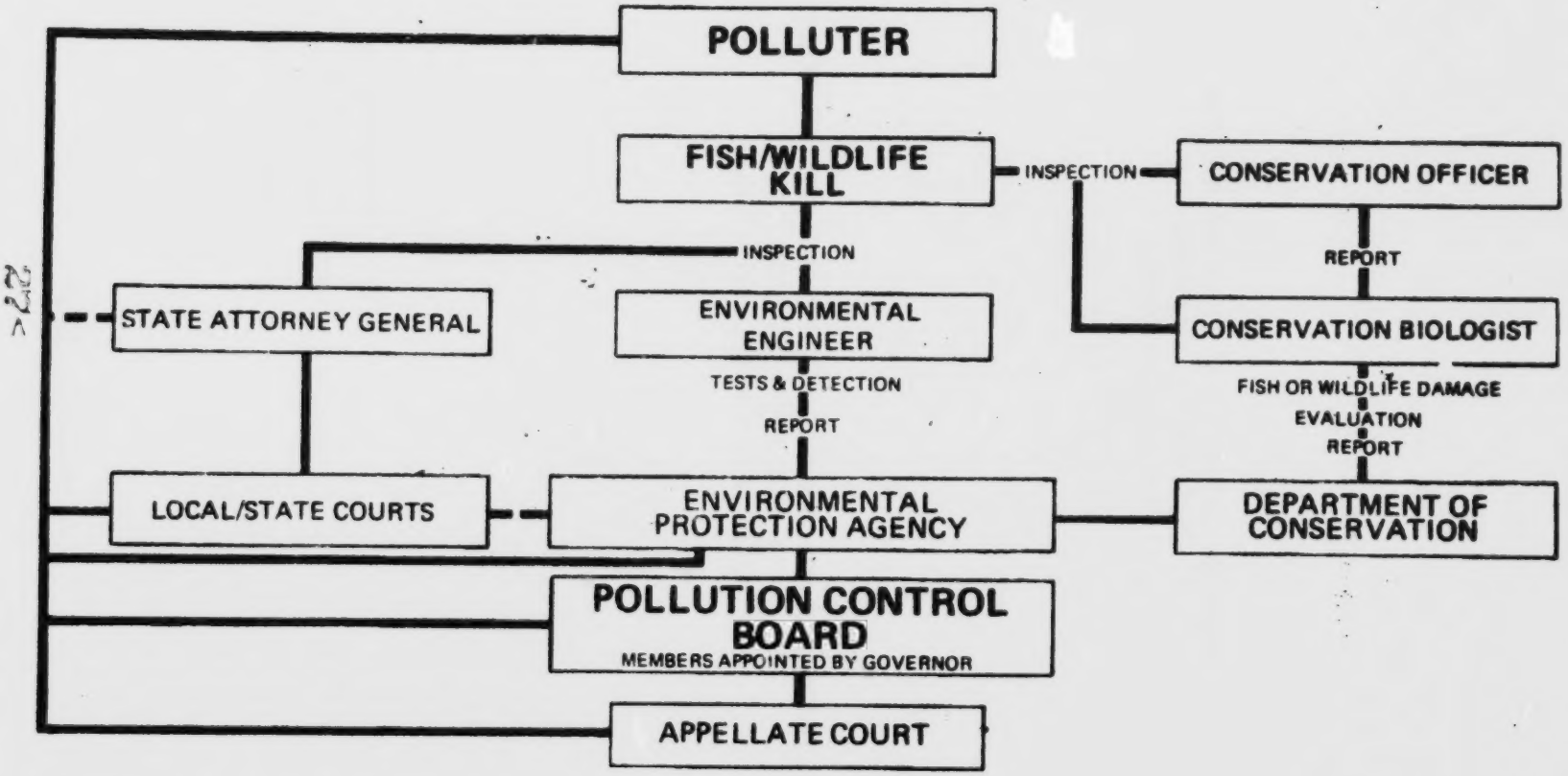
State Representatives

ILLINOIS DEPARTMENT OF CONSERVATION
DIVISION OF FISHERIES
Springfield, Illinois

PROCEDURES USED BY THE ILLINOIS DEPARTMENT OF CONSERVATION IN THE INVESTIGATION OF POLLUTION CAUSED FISH KILLS

Presented by
A. C. Lopinot
Chief Fishery Biologist
January 1971

ILLINOIS POLLUTION ABATEMENT PROCEDURE



OUTLINE OF STEPS TO BE FOLLOWED IN ILLINOIS POLLUTION CASES

POLLUTION CASES INVOLVING FISH KILLS

1. The Division of Fisheries in the Department of Conservation and/or the Environmental Protection Agency is notified.

2. The Environmental Protection Agency notifies their field engineer to make an investigation. The Division of Fisheries notifies local fishery biologist to make investigation.

3. The environmental engineer takes pH, D.O., B.O.D., tests and/or samples for the various chemical pollutants suspected. Samples are sent to the Division of Laboratories at Springfield for analysis. The fishery biologist counts fish that are killed as to species and size.

4. The environmental engineer writes a narrative report of observations and results of the tests he has made. This is sent to the Springfield office with a copy going to the Division of Fisheries. The fishery biologist fills out a pollution report form and estimates the number, kind, and size of fish killed in the area polluted. This report is sent to the Springfield office with a copy to the Environmental Protection Agency.

5. If the damages warrant further action, the reports are then brought before the Environmental Protection Agency or the Pollution Control Board.

6. The Environmental Protection Agency reviews the report and makes recommendations as to whether the case should be turned over to the Pollution Control Board.

POLLUTION CAUSED FISH KILL INVESTIGATION

The Division of Fisheries of the Illinois Department of Conservation is responsible for making an investigation of a major fish kill caused by pollution. Upon receipt of information regarding a pollution fish kill, the Environmental Protection Agency is to be notified by the fishery biologist making the investigation. The environmental engineer will be responsible for making any physical or chemical tests in the polluted area. The fishery biologist's investigation will consist of the following:

1. Determine the extent of the fish kill area.

   Streams: Establish upstream and downstream limits

   Lakes: Total surface area involved

2. Make detailed counts of fish killed by species and size groups at various stations located within the kill area.

3. Determine the total number and value of fish killed.

4. Water tests such as D.O. and pH may be taken if the fishery biologist feels they are essential for his report but they are not required.

5. Summarize the data collected and file reports to the Division of Fisheries.

The procedures for making the fish kill estimate is as follows:

1. A minimum of three sampling stations should be taken within the area of the fish kill. These stations should be evenly distributed throughout the kill area.

2. Each station should consist of a measured area:

   Streams: Measure length of section being sampled in feet.

   Lakes: Measure station as shoreline length, square feet or surface acres.

3. At each station, all of the fish should be separated into size groups by species and counted. The size grouping will be done according to that listed in the standard price list. A sample of the fish will have to be measured and/or weighed.

4. All of the sampling stations are to be averaged as to area.

   Streams: Length in feet

   Lakes: Square feet or acres

5. A multiplying factor is used to determine the estimated total number of fish killed by species size group.

6. The value per fish (from standard price list) of each species size group is multiplied by the estimated total number to determine the total value.

7. The total value of all species and sizes will give the total estimated damages done to the fish in the area affected by the pollution fish kill.

The procedures for reporting the fish kill damages are as follows:

1. The fishery biologist making the investigation will write a

narrative report in factual style of his investigations to include observations, any tests made, physical damages and total monetary value of damages done to fish life. The following should be a guide to writing this report:

A. Be factual - avoid hearsay, opinions, judgements. Use: where, when, who, what.

B. Title should be carried over on each page.

C. Use the word "I". Who was informed, where was the fish kill.

D. Give the number of times, names, dates, be more specific.

E. Give information in a chronological fashion.

F. Always state where information was obtained.

G. Don't give opinions such as normal.

H. Give estimated number rather than exact number.

I. All reports should be signed with full name, title and address.

J. Be sure to mention weather conditions prior to kill.

K. Background information should be separate from report.

L. Conservation officers should be informed to call the Environmental Engineers concerning a fish kill.

M. On occasion, take a water sample when an engineer is not available - particularly when fish are in distress. The sample should be at least a quart of water. Dissolved oxygen and pH tests should be run when an environmental engineer is not on the case.

N. Do not state source of pollution that has been traced. Describe stream instead.

O. Make no decisions without facts.

P. State in narrative that there is an appended sketch of the stream showing area affected.

Q. Photographs with the report would be helpful but are not absolutely necessary.

R. Do not list a company as a specific cause even though you may know the cause.

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2. A map is to be drawn of the polluted area showing the stream or lake with roads, bridges, nearby towns, sampling station locations (numbered as listed in report form), area of fish kill, known sources of pollution, and any other pertinent information that might be of value in the pollution case.

3. A title page for the report will be made up as follows:

(Top of Page): Illinois Department of Conservation
Division of Fisheries

REPORT OF POLLUTION CAUSED FISH KILL INVESTIGATION

(Center of Page): OF _____ IN _____ COUNTY
(Name of Water) (Name)

ON _____
(Date)

(Lower right-hand corner): Submitted by:
Name of Biologist
Title
Date

4. The report of the pollution caused fish kill will be assembled in the following order:
   a. Title page
   b. Narrative report
   c. Report form - page 1
   d. Report form - page 2
   e. Map of area

5. The report will be submitted immediately, without delay, to the following:
   a. District fishery biologist
   b. Area fishery biologist
   c. Two copies to Division of Fisheries (one will be forwarded to the Environmental Protection Agency).

ILLINOIS DEPARTMENT OF CONSERVATION
DIVISION OF FISHERIES

STANDARD PRICE LIST OF FISH FOR POLLUTION FISH KILLS

(Based on 1971 Commercial Values)

SPECIES	SIZE GROUP	VALUE PER FISH
GAME FISH		
Bass (including largemouth, smallmouth and spotted)	1 to 6 inches	$0.47
	7 to 11 inches	$1.10
	12 inches plus	$2.08
Sunfish (including bluegill, warmouth, rock bass, green sunfish, white and yellow bass)	1 to 5 inches	$0.30
	6 to 7 inches	$0.61
	8 inches plus	$1.00
Catfish (including channel, blue, flathead, all species of bullheads)	1 to 6 inches	$0.09
	7 to 11 inches	$0.16
	12 inches plus	$0.71/lb.
Pike (including walleye, sauger and northern)	All sizes	$1.64
Trout (all species)	All sizes	$1.16
NON-GAME FISH		
Minnows (all species)	All sizes	$0.03
Bowfin	All sizes	$0.04/lb.
Gar	All sizes	$0.05/lb.
Shad	All sizes	No charge
COMMERCIAL FISH		
Carp (including carpsucker, redhorse sucker and other species of suckers)	0 to 1 pound (0.5)	$0.04
	1 to 5 pounds (3.0)	$0.21
	5 to 10 pounds (7.5)	$0.53
	10 pounds plus	$0.07/lb.
Buffalo (all species)	0 to 1 pound (0.5)	$0.06
	1 to 5 pounds (3.0)	$0.36
	5 to 10 pounds (7.5)	$0.90
	10 pounds plus	$0.12/lb.
Freshwater drum	0 to 1 pound (0.5)	$0.05
	1 to 2 pounds (1.5)	$0.14
	2 to 5 pounds (3.5)	$0.32
	5 pounds plus	$0.09/lb.
Bullheads (all species)		$0.17/lb.
Catfish (including large size channel, flathead, blue and white)		$0.32/lb.
Sturgeon (all species)		$0.20/lb.
Paddlefish		$0.13/lb.
Eel		$0.12/lb.
Mooneye & Goldeye		$0.05/lb.
Turtles		$0.26/lb.

Sources of prices on file in Division of Fisheries office at Springfield, Illinois. For prices of fish not listed, consultation with the Division of Fisheries Central Office is required.

STATE OF ILLINOIS
RICHARD B. OGILVIE, GOVERNOR
DEPARTMENT OF CONSERVATION
102 STATE OFFICE BUILDING
400 SOUTH SPRING ST.
SPRINGFIELD 62706

CHICAGO OFFICE — 160 N. LA SALLE ST.

TO: All Conservation Employees

FROM: Director, Department of Conservation

SUBJECT: Procedure To Be Followed in Pollution Cases

In the past there has been some misunderstanding concerning the duties of Department personnel in pollution cases. Therefore, to clarify those duties and to insure the Department meets its responsibilities in cases involving pollution, the following procedures will be carried out:

1. When a report of pollution is received, an initial inspection is to be made immediately by the county conservation officer to determine whether any damage has occurred to fish or wildlife.

2. If the conservation officer's initial inspection reveals that fish or wildlife are being or have been affected, he will contact the appropriate district fishery or game biologist immediately. If fish or wildlife are not being or have not been affected, the conservation officer will contact the district biologist who will in turn phone the nearest Regional office of the Environmental Protection Agency and also notify the Springfield office of the Division of Fisheries or Wildlife Resources. (All calls from conservation officers to biologists are to be made collect.)

3. Upon being notified by a conservation officer of a fish or wildlife kill, which is believed to have been caused by pollution, the biologist will call the nearest Regional office of the Environmental Protection Agency.

4. After contacting the environmental engineer, the biologist will then proceed to the kill area and perform his investigation. The conservation officer is to assist the biologist wherever required.

Pollution kills are to be considered top priority and these investigations are not to be delayed. If there are prior commitments on other work, arrangements should be made to see that prior commitments are satisfactorily accomplished.

The following statements are made to point out certain responsibilities and policies regarding pollution cases:

1. The biologists' primary responsibility in a pollution caused kill of fish or wildlife is to prepare a monetary estimate of fishes or wildlife destroyed. It is not his responsibility or that of the conservation officer to take water samples.

2. Biologists or conservation officers are not to investigate sewage treatment plants, industrial effluent treatment plants, coal mines, canneries, dairies or other possible sources of pollution to make recommendations for pollution control or to try to determine whether the operation in question is actually causing pollution. Such investigations require the attention of personnel trained in sanitary engineering and are therefore the responsibility of the Environmental Protection Agency.

3. The conservation officer or biologist should not identify himself as an enforcer of pollution laws. The legal pollution abatement agency in the State of Illinois is the Environmental Protection Agency and Pollution Control Board. Actions or injunctions against a pollutor shall be taken by these agencies.

4. Department personnel are not to make public or private comment about the results of a pollution investigation since the information obtained may be used in court.

ILLINOIS DEPARTMENT OF CONSERVATION
DIVISION OF FISHERIES

REPORT OF POLLUTION-CAUSED FISH KILL

County_____
Nearest Town_____
Date_____

WATER (name)_____
Owner_____ Address_____

1. Reported by_____ Date_____
2. Persons contacted:_____
3. Sanitary Engineer notified: Date_____ Time_____
   Name_____ Address_____
4. Source of pollution:

A. AGRICULTURAL OPERATIONS

- ☐ Poisons (herbicides, pesticides, etc.)
- ☐ Fertilizers
- ☐ Manure drainage, ensilage liquors, or feed lot operations

B. INDUSTRIAL OPERATIONS

- ☐ Mining
- ☐ Food & kindred products
- ☐ Paper & allied products
- ☐ Chemicals
- ☐ Petroleum
- ☐ Metals
- ☐ Other (specify) _____

C. MUNICIPAL OPERATIONS

- ☐ Sewage system
- ☐ Refuge disposal
- ☐ Water system
- ☐ Swimming Pool

D. TRANSPORTATION OPERATIONS

- ☐ Rail
- ☐ Truck
- ☐ Barge or boat
- ☐ Pipeline

E. ☐ OTHER _____

F. ☐ UNKNOWN

G. SPECIFIC AGENT OR CAUSE IF KNOWN_____

5: Type of Fish Killed: Game: _____%
Non-Game: _____%
Total: 100

What percent of the above two types are commercial: _____%

6. Estimated total number of fish killed:_____ Value: $_____
7. Severity: ☐ Total ☐ Heavy ☐ Moderate ☐ Light
8. Extent: Area of fish kill (miles or acres)_____
9. Duration of critical effect: _____ Days _____ Hours
10. Sampling station locations:

Station Number	Location				Time	Remarks
	County	Township	Range	¼ Section		

11. Additional comments:_____

12. Date of Report_____ Biologist:_____

FM 19.0 3/63 (69195—5M Sets—2-63)

FISH COLLECTION

WATER (name)_____

Area of fish kill: Miles or acres_____ Length in feet_____

Multiplying factor obtained by taking average length (or area) of all stations divided into total length (or area) affected.

Species	Size Group	Number of fish killed at each station					Average of all Stations	Multiplying Factor	Estimated Total Number Killed	Value Per Fish	Total Value
Station No.											
Length of sta. in ft. or (area)											
		GAME FISH									
BASS	1-6 in.										
	7-10 in.										
	11 in.+										
SUNFISH	1-5 in.										
	6-7 in.										
	8 in.+										
CATFISH	1-6 in.										
	7-11 in.										
	12 in.+										
		NON-GAME FISH									
MINNOWS											
SHAD											
		COMMERCIAL FISH									
CARP	0-1 lbs.										
	1-5 lbs.										
	5-10 lbs.										
	10 lbs.+										
BUFFALO	0-1 lbs.										
	1-5 lbs.										
	5-10 lbs.										
	10 lbs.+										
DRUM	0-1 lbs.										
	1-2 lbs.										
	2-5 lbs.										
	5 lbs.+										

GRAND TOTAL | | (Number) | (Value)

Biologist_____

FM 19.1 3/63 (69195—5M Sets—2-63)

Procedures for Completion of

POLLUTION-CAUSED FISH KILL REPORT

(If no fish are killed or if the kill is less than $100.00 in value, a Supplemental Survey report form should be used to report the kill.)

County: Record all counties if several are involved but list first the county in which the major portion of the water area affected is located.

Nearest Town: Record nearest major town to water area.

Date: Record date of fish kill investigation.

Water (Name): Record name of water area.

Owner: Record name of owner of water area (for impoundments only).

Address: Record address of owner.

1. Reported by: Record name of person that first reported fish kill to personnel of either Department of Conservation or Environmental Protection Agency.

2. Persons contacted: Record names and addresses of persons contacted in regard to fish kill and pollution.

3. Environmental Engineer notified:

   Date: Record date engineer was notified.

   Time: Record time engineer was notified.

   Name: Record name of environmental engineer notified.

   Address: Record address of environmental engineer notified.

4. Source of pollution: Check appropriate box.

   A. Agricultural Operations

   1. Poisons: Include any of the insecticides or pesticides after delivery to the farm no matter how they got into the stream.

   2. Fertilizers: Include commercial fertilizers after delivery to farm.

   3. Manure drainage, ensilage liquors, feed lot operations: This category is not restricted to these items but is intended to include all causes brought about by poor "housekeeping." Exclude commercial dairy operations.

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B. Industrial Operations

Consider industrial operations as a cause only if there are separate discharges and the pollutant does not go through municipal sewers.

1. Mining: Include minerals and coal but exclude petroleum or gas.

2. Food and kindred products: Include any food or animal feed product in any stage of manufacture. This is meant to include commercial dairies.

3. Paper and allied products: Include paper in any stage of manufacture.

4. Chemicals: Include chemicals of all kinds. This is meant to include commercial fertilizers, except those already delivered to, or in transit to the farm.

5. Petroleum: Include all gas and oil activities except pipeline transportation.

6. Metals: Include any metal or metal product manufactured from blast furnace to finished item.

7. Other: Include any industries not classified above. These would be lumber and wood products, textiles, rubber or leather, etc. Specify.

C. Municipal Operations

This section is intended to cover those activities that are the responsibility of the municipality in the maintenance of services.

1. Sewage system: Include industrial wastes which pass through the system; also include insecticides for fly control, and the improper disposal of chemicals.

2. Refuse disposal: Include kills caused by poor management of dumps or incinerators.

3. Water system: Include kills caused by poor management, excessive use of chemicals or pesticides.

4. Swimming pool: Include excessive use of chlorine for cleaning operations.

D. Transportation Operations:

This section covers products in transit by the indicated means regardless of source or destination or ultimate use. It also includes wastes resulting from that means of transportation. "Pipeline" in this instance refers to those lines for cross-country transportation of liquids or gases. A line break within a plant or between two nearby plants should be considered under industrial operations.

E. Other Operations:

If the cause is known but cannot be placed in any of the four preceding groups, enter here and specify.

F. Unknown:

Use only if cause cannot be determined or reasonably surmised.

G. Specific agent or cause, if known:

This space is for the name of the pollutant (from the operation checked above) which caused the fish kill.

5. Type of fish killed:

Game - percent: Give percent of fish classified as game species for the total area affected.

Non-game - percent: Give percent of fish classified as non-game species for total area affected.

Both of the above should total 100 percent.

What percent of the above two types are commercial: Give percent of the total dead fish, whether game or non-game, which were of commerically valuable species.

6. Estimated total number of fish killed: Record total number of fish killed in pollution case - figured from sampling stations.

Value: Record total value of all fish killed - figure from sampling stations.

7. Severity: Check appropriate box which in your opinion best describes the severity.

8. Extent: Area of fish kill (miles or acres) Record total area of the fish kill in miles for streams and acres for impoundments.

9. Duration of critical effect: Days - Hours: Record total number of days or hours that fish kill was in progress.

10. Sampling Station Location:

Station number: Record station number - to be located on map.

Location: County, Township, Range, 1/4 Section: Record county, township, range and nearest quarter section where sampling station is located. May be obtained from plat book or county highway map.

Time: Record time fish were counted and size grouped.

Remarks: Record any comments concerning station location or condition.

11. Additional comments: Record any comments pertinent to pollution-fish kill investigation.

12. Date of report: Record date report was completed.

Biologist: Record name of biologist(s) doing survey and writing report.

FISH COLLECTION

Water (name): Record name of water area.

Area of fish kill: Miles or acres: Record area of total fish kill in miles for streams and acres for impoundments.

Length in feet: For streams only, record total fish kill area in stream length feet - for purpose of determining multiplying factor.

Station Number: Record number of station - should correspond to Page 1 of pollution report. If more stations are sampled than there is room for on this report, use an extra page of Page 2.

Length of station in feet (or area): Record length of station in feet or in area (square feet or acres).

Species - Size group: The major species of fish and the size groups that they are to be counted in are recorded on this form. For the additional species of fish not listed, record their name and size groups as necessary from standard price list.

Number of fish killed at each station: Record total number of dead fish for each size group and species found within sample station.

Average of all stations: In order to compute the total number of fish killed in section of stream or lake, the number of fish by species and size groups should be added and divided by the total number of stations sampled to obtain an average. This average is recorded in this section.

Multiplying factor: The multiplying factor is obtained by taking average length (or area) of all stations divided into total length (or area) affected. This factor is then recorded in the column provided for each species of fish being estimated.

Estimated total number killed: The total number of fish killed can be determined by multiplying the "multiplying factor" by the average number of fish for all stations.

Value per fish: The value for each species and size group should be recorded in this column as previously determined from standard price list.

Total Value: Record the total value for each species and size group by multiplying the value per fish times the estimated total number killed.

Grand Total: Numbers - Value: Add the columns and record grand total for numbers of fish killed and for value of fish killed.

Biologist: Record name of biologist(s) doing survey and writing report.

NOTE: Be sure to check all figures for correct addition, multiplication and division before typing final report. All reports are to be typed.

Procedures for Completion of

POLLUTION SURVEY MAP

County: Record county in which pollution occurred.

Location: T: Record township name and number where pollution occurred.
R: Record range number where pollution occurred.
S: Record section number where pollution occurred.

Dates: Record dates on which pollution survey was made.

Draw a map of the polluted area showing roads, bridges, nearby towns, sampling stations, area of fish kill, known source of pollution (should be colored), and any other pertinent information that might be of value in the pollution case. If there are no pollution survey map forms available or they are not large enough, other paper map be used but the standardized heading should be used on the map.

Biologist: Record name of biologist making pollution survey map.

ILLINOIS POLLUTION CAUSED FISH KILLS
1960-1970

YEAR	Number	Streams Miles	Lakes Acres	Estimated Total Number of Fish Killed	Value of Fish ($)
1960	13	81.65	--------	207,729	33,797.82
1961	23	150.00	--------	5,648,171	434,457.70
1962	14	127.80	--------	295,111	60,590.37
1963	37	184.60	375.70	805,278	84,453.48
1964	20	150.65	201.30	3,950,307	33,254.30
1965	19	98.15	32.40	444,326	48,590.00
1966	13	77.10	0.41	1,331,526	31,018.00
1967	11	50.25	--------	160,562	11,643.00
1968	10	59.50	1,187.00	379,107	16,662.00
1969	13	49.60	--------	313,642	91,942.00
1970	8	43.60	--------	106,194	14,050.09
Total	181	1,072.90	1,796.81	13,641,953	860,458.76

KENTUCKY'S FISH KILL INVESTIGATION PROGRAM

By
Peter W. Pfeiffer, Assistant Director
Division of Fisheries
Kentucky Department Of Fish & Wildlife Resources

In Kentucky, the State Water Pollution Control Commission has the primary responsibility for the detection and abatement of water pollution. The investigative obligation of this commission is to determine the full physical and chemical impact of the pollutant upon the receiving waters. The Department of Fish and Wildlife Resources through a memorandum of understanding with the commission is responsible for reporting occurences of water pollution and for determining the biological damages i.e. the fish and associated stream biota.

After these investigations have been made, the Water Pollution Control Commission is then responsible for implementing legal proceedings that can force the pollutor to renumerated to the State the replacement value of the fish that were killed, the cost of the fisheries investigation and if warranted a fine of up to $1,000 per day of continued pollution.

The monies collected for the damage to the fishery are then held in escrow until our Department restocks the waters that were polluted or adjacent waters that would provide fishing opportunities for the people in the area of the fish kill.

From September of 1968 thru 1969 our Department assessed damages to the fisheries of Kentucky resulting from pollution in an amount exceeding $60,000. In every instance where the Water Pollution Control Commission has attempted to collect for fishery damages they were successful. Consequently, in 1970, we decided that if we didn't want our record spoiled we had better standardize our procedures and give our monetary values a stronger basis for assessment. In the past our judgements had been somewhat arbitrary while our monetary values of fishes were based on very flimsy data. As a result, last year in 1970 our Division compiled a manual which includes standard procedures for investigating

fish kills and incidences of water pollution and a price list entitled Monetary Values of Fish which was prepared by the Pollution Committee of the Southern Division of the American Fisheries Society and adopted by them at their 1970 annual meeting.

The investigative procedures outlined in our manual are essentially as follows:

1. When a fish kill is reported to us we first confirm it it with our conservation officer and then notify the Water Pollution Control Commission.
2. We then send a biologist to assess the biological damage.
3. The Water Pollution Control Commission will also send a staff member to determine physical and chemical impact.
4. The biologist, together with the conservation officer, collect water samples, make routine water quality determinations, take photographic evidence, measure the total area of the kill and by sampling assess the loss of fisheries, that is the species, number, and lengths.

The loss in fisheries data are then expanded to give the estimated total number of fish killed, catagorized by size groups for each species. Each size group is then assigned a value (taken from the monetary value of fish). The total of all the fishes in terms of dollars, along, with the expenses to conduct the investigation, and the fish transportation charges then represent the total replacement cost of the fishes in the area affected by the pollution. Copies of this report are then forwarded to the Water Pollution Control Commission for legal action.

If for some reason we arrive at the scene of a fish kill some days after it initially started and it is impossible to assess the damage because of decomposition or other factors we can go to a representation section of the same stream that was not affected and conduct a population study and make our projections for the fish kill area from those data.

I think a very important lesson that we have learned over the past few years in working with pollution caused fish kills is the importance of keeping the various personnel on our own staff and other agencys informed as regards the progress, or status or action being taken on a particular case. There is nothing more frustrating to a member of an investigating team than it is to have information flow in only one direction.

Presentation for Fish Kill Investigation Seminar
Cincinnati, Ohio
12-14 January 1971
Fish and Wildlife Administration
Annapolis, Maryland 21401

Maryland is probably one of the smallest states represented here at the Conference. However, the magnitude and complexity of the Chesapeake Bay system and its economic importance to the Mid-Atlantic States obviously merits special consideration. The Bay is nearly 200 miles long and up to 30 miles wide. About 50 major rivers and countless small tributaries empty into the Chesapeake Bay, draining approximately 74,000 square miles of water from New York, Pennsylvania, West Virginia, Virginia, Delaware, and Maryland.

One-fourth of Maryland's total area is water and 70% of the water is tidal. These tidal waters are important spawning and nursery grounds for almost 200 species of anadromous and resident fish, about 40 of which have direct economic and recreational value. The shellfish industry in Maryland, particularly the oyster, blue crab, and soft-shell clam industries, is one of the largest in the country. At least 10,000 Marylanders are commercial watermen.

Some of Maryland's waterways pose particular problems. The Baltimore Harbor area of the Patapsco River is a nightmare for fish kill investigations. In addition to municipal wastes from well over 1 million people, these waters receive effluents from 1245 manufacturing firms, including chemical, fertilizer, and pesticide plants. Another problem area is that section of the Potomac River which receives sewage effluents from the Washington, D.C. area. Both of these water areas are spawning and nursery grounds for important fish species, such as striped bass, white perch, yellow perch, herring, menhaden and blue crabs, and are sites of fish mortalities.

Although the State of Maryland has been responding to fish kill complaints for decades, our investigational procedures are still evolving. A giant forward stride occurred in August 1969, when the Maryland General Assembly enacted a law empowering state agencies to investigate fish kills and to seek reparations for damages to aquatic resources within the State, where the responsible party can be identified. This law has yet to be court-tested, but two companies have offered voluntary restitutions since its enactment.

In the past, fish kill reports were haphazardly investigated because there was no clear cut delegation of responsibility to any agency within the State. Each institution responded to a major fish kill complaint when it was convenient for them. Not infrequently, there were no investigations. In 1963, the responsibility of primary investigation of fish kills in tidal waters was delegated to the tidewater management agency. Inland waters were under the jurisdiction of a separate agency. A recent major consolidation of agencies concerned with tidal and inland waters resulted in the emergence of one primary investigative agency, the Fish and Wildlife Administration. The Department of Water Resources is primarily an enforcement agency and has the authority to seek reparations.

At present, the Fish and Wildlife Administration makes an initial estimate of the damage to the fishery, taking water and fish samples, measurements of dissolved oxygen, temperature and pH. If the kill is a significant one and if pollution is suspected, the Department of Water Resources becomes involved. A task force, composed of members of the

Department of Water Resources, the Fish and Wildlife Administration, and the State Health Department continues the investigation, interviewing witnesses, determining limits and size of the kill, and estimating damage to fish and other aquatic organisms. Water samples are analyzed in the laboratory of the Department of Water Resources. If the task force is able to locate the source, a complete report is submitted to the Department of Water Resources, which may then forward the report to the Attorney General for further action.

Most fish kills in Maryland occur in the estuaries and are believed to be related to dissolved oxygen extremes, sometimes caused by plankton blooms, and salinity and temperature changes. Disease plays a smaller role as the cause of fish kills. However, in 1963 an infectious bacterium killed hundreds of millions of white perch and a small number of striped bass. Sport and commercial fishery discards constitute at least one-fourth of all fish kill complaints. Known pollution sources cause only about one-tenth of the total number of fish kills. However, many kills below municipal and industrial outfalls remain unsolved.

Today the climate in the United States demands efficient fish kill investigations. The public reacts to environmental abuse and the judiciary is more willing to listen to pollution cases in court. We feel that Maryland's fish kill program is making significant progress in developing highly competent investigative procedures. We have increased our personnel to include biologists familiar with disease problems and have expanded a laboratory for autopsies and bioassays. We are learning to recognize the effects of pollutants on

fish and are continuing our research on chronic problems, such as the annual menhaden mortality, which alone results in the death of hundreds of thousands of fish each summer. In spite of these advances, there is need for additional consolidation within the state agencies. We look forward to the formation of multi-discipline fish kill teams, such as many other states are now using, and a more centrally located biological laboratory. Although we can not yet report having solved the major number of fish kills and in collecting damages from polluters, we feel we have made considerable headway toward the goal of cleaner water. We welcome such a meeting as this and hope that we have the opportunity to talk to our more experienced neighboring states.

March 12, 1971

FISH KILL PROSECUTION IN THE STATE OF NEW YORK

With the transfer of the enforcement of the Classification-Standards provided under Article 12 of the Public Health Laws to the Department of Environmental Conservation on July 1, 1970, fish kill may be prosecuted under two laws, Section 180 of the Conservation Law and Article 12 of the Public Health Laws.

Section 180 makes it a violation to throw, or allow to run in any waters of the State, any substance injurious to the fish or wildlife inhabiting the same or detrimental to their propagation therein. Prosecution may be criminally with a penalty of $500 or 1 year in jail, or both such penalty and imprisonment or civilly with a penalty of $500 to $1000 for the offense. In either case, the law provides that $10 a fish may be collected for fish killed. It should be noted, that under this section penalty can be obtained for a condition which would cause fish kill even where no fish are present to be killed.

Under Article 12 penalty for violation of standards of the classification can reach $2500. Any fish kill cannot help but violate the standards in all classifications of fresh waters. A choice is present in case of fish kill under which laws the violation shall be prosecuted. Also any violation of a specified standard can also be prosecuted.

Pollution investigations involve an interdisciplinary approach involving a chemical-biological team. If an investigation by a Conservation Officer (Law Enforcement) establishes a kill occurred within the previous 24 hours, he calls a pollution unit on reverse charge. He may receive directions at this time to collect samples at specific locations thus providing sampling before the unit can reach the scene. Chemical samples are obtained and the suspected source is visited and information on operations obtained after the pollution unit reaches the location. Both chemical analyses and bio-assay to establish the source and prima facie evidence of violation may have to be conducted at the base laboratory. Prosecution is not recommended unless such evidence is obtained. Success is dependent upon how rapidly the fish kill can be investigated.

Two units cover the entire state on such calls. Instrumentation is used to save laboratory time in analysis. Instrumentation in the Bureau includes colorimetric and U.V. spectrophotometers, gas-liquid chromatographs, atomic absorption spectrophotometry, infra red analyses and laboratories equippedfor more laborious analytical determinations. Determination of probable cause of kills is becoming more efficient yearly.

SUMMARY OF PRESENTATION
FISH KILL INVESTIGATION SEMINAR

By

John C. Murdock, III
Regional Engineer
Industrian Waste Branch
State of North Carolina
Department of Water and Air Resources

Fish Kill investigations in the State of North Carolina are the responsibility of the North Carolina Department of Water and Air Resources and the North Carolina Wildlife Resources Commission. The Wildlife Resources Commission has the responsibility of collecting, weighing, identifying, and determining the cost of the fish killed. The Department of Water and Air Resources is responsible for conducting the investigation which includes checking all waste discharges and the collection of all samples.

All Fish Kills are investigated to try to determine the reason for the kill and if sufficient evidence is found to pinpoint the cause to an individual or company and the number of fish killed is greater than 100, we collect for the cost of the investigation and the cost of replacing the fish.

The Law authorizing the Board of Water and Air Resources to collect for Fish Kills is a civil law. All of the personnel investigating Fish Kills with the Department of Water and Air Resources are Chemists and Engineers.

Topic: Fish Kill Program of the Ohio Department of Natural Resources, Division of Wildlife

Presented by Paul C. Woner, Pollution Specialist at the January 12-14, 1971 Fish Kill Investigation Seminar sponsored by Environmental Protection Agency and Ohio Cooperative Fishery Unit of the Ohio State University.

GENERAL

The Ohio Department of Natural Resources, Division of Wildlife in carrying out its mandate to protect and propagate fish and wildlife, investigates all reported fish kills with the objective of determining the cause of the kill. If the investigation reveals the cause to be the direct result of a pollutant and the source of this pollutant can be determined, a claim for damages based upon the current wholesale market value of the wild animals destroyed is submitted to the party responsible. Our price list is periodically revised to keep it current with market fluctuations.

Small or reocurring pollution problems, not involving the death of more than $25.00 worth of wild animals are also investigated by the fieldmen, normally the county game protector. The data obtained is submitted to the Department of Health, Division of Engineering and/or the Department of Natural Resources, division of oil and gas for corrective action.

Although it is not entirely a fixed policy, we normally use the $25.00 value of the wild animals destroyed as the cut-off between fish kills which are fully investigated and those which receive only a summary investigation.

We adopted this policy after a study of the cases we had investigated in former years. It was found that the small fish kills far outnumbered those in excess of $25.00 in value, but only constituted about 1% of the total number of wild animals killed. Since they were costly to investigate fully and since the vast number of water samples collected in these small cases tended to bog down the laboratory, we adopted the $25.00 cut-off figure. This procedure has allowed our personnel greater freedom to devote their time and skills to the investigation of the major fish kills.

Although it may be attempted at some future date, we have not as yet submitted any claims for habitat damage. This we believe would require that we have considerable biological data relative to the condition of the stream in question prior to the damage in the degraded area.

PROCEDURE

Virtually all water pollution investigations made by the Division of Wildlife begin with the local game protector. First he assesses the magnitude of the problem, makes a determination of the apparent source of the pollution, and the number of wild animals affected. If it is his judgment that the pollution has or is likely to cause a fish kill in excess of $25.00 in value, he contacts his district supervisor and informs him of the particulars. He then begins collecting water samples, specimens of dead or dying wild animals and other pertinent materials that may be used as evidence.

The District Supervisor usually turns the case over to the District Law Enforcement Section Supervisor who assigns an Enforcement Agent to the case. A District Fish Management Biologist may also be assigned or voluntarily assist, but this is not normally required. Generally, unless the case appears to be exceptionally large and complex, all of the field investigation is conducted by the game protector and the enforcement agent.

Upon arrival at the scene the wildlife enforcement agent takes charge of the investigation, checks the samples collected by the game protector and determines if additional samples are required. He may be aided in this regard by information provided by the Columbus Law Enforcement Office, by the Health Department or from witnesses. The agent is equipped with a simple water test kit. He makes field tests for dissolved oxygen, p^H, and takes the air and water temperature preferably at the locations at which the Game Protector has taken samples. The agent also notes the water color, odor, transparency, rate of flow and any other pertinent information. Both the agent and the Game Protector have some chemicals for preserving samples as well as fluorescein dye.

The prelimenary work out of the way, the agent then begins to gather and document the evidence that will be used to build the case against the responsible party. This may include interviewing witnesses, questioning plant officials and technicians, studying blueprints of a section of the city sewerage system, taking photographs and the collection of any other pertinent evidence. Once the prelimenary investigative work is completed he may assist the Game Protector or fisheries people in making a count of the wild animals destroyed.

Coordination between the man in the field, the district, and the Columbus Office is maintained throughout the investigation. It continues up to the time the case is closed.

The Headquarters Enforcement Office coordinates with the Ohio Department of Health, Division of Laboratories and Division of Engineering and other state or federal agencies as required. Any information obtained from these sources is relayed back to the district for action or addition to the case file.

The investigation is pursued, largely on the district level, until all available evidence and data has been obtained and compiled.

A typical case file contains all of the information collected by the agent, his report, the laboratory test results from the water and/or fish specimens collected, the tabulated fish kill, the results of the water tests made in the field, a biological interpretation of the data, all signed receipts used to maintain the chain of evidence, data collected from outside sources such as other industries, sewage treatment plants etc., maps showing the existing situation, kill count stations, and water sample stations, a list of the principals involved, and a table showing the number of wild animals killed, their value and the costs involved in conducting the investigation.

After the case file is completed it is reviewed in the District by the Law Enforcement Supervisor and the District Supervisor. They record their recommendations on a cover form and forward the case file to the Division Enforcement Headquarters. This case file is again reviewed by the Enforcement Supervisor, the Pollution Specialist and the Assistant Attorney General assigned to Wildlife. Cases which have been determined to contain the necessary evidence to prove that a fish kill resulted from a specific source are given to the Assistant Attorney General for collection we attempt to collect both the damages incurred and the investigative costs.

Completed or closed cases including those under $25.00 in value are data punched on keysort cards for quick referral.

ACCOMPLISHMENTS

We believe our program to be basically a sound workable one. Since 1964, the year we began an intensive program of fish kill prosecution through the Law Enforcement Section, we have collected 70 claims for a total of $174,198.80. Last week, the largest claim the Division of Wildlife has collected since 1947 when it began submitting damage claims, was paid to us by a paper company for $60,361.13.

We have also been credited with having made the first collection of damages for a fish kill resulting from thermal pollution., (A sugar company for $3,241.09).

STREAM LITTER

Although not generally connected with fish kills, we have an intensive program of stream litter enforcement. Since amended substitute Senate Bill #345 became effective on June 5, 1968, we have made 1665 arrests on 319 streams and 57 lakes and in all of Ohio's 88 counties.

Out of this total we have lost but 8 cases. Through 1970 the total amount of fines assessed was 59,997.03; 16,615.70 of which was suspended by the court.

This program has been very successful in the drive to clean up Ohio streams. People still continue to litter, but we have observed that people are no longer dumping as much along the streams as they are along the highways. We have therefore, at least, succeeded in relocating the litter.

CONCLUSION

Due to the limited time available we have covered only the major points. Anyone interested in any of the specifics of our program is welcome to contact us at anytime.

FISH KILL INVESTIGATION PROCEDURES
INDIANA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH & WILDLIFE

1. Fish Kill spotted.

2. Investigated by State Conservation Officer, who makes visual observations and reports the severity of the kill.

3. Indiana State Board of Health is contacted and tries to determine cause and source of the kill. They take water samples and any other data they feel important in solving the fish kill.

4. A fisheries biologist is usually contacted and together with the conservation officer conduct a fish count. Number, size, and species are recorded.

5. All reports forwarded to the director's office - Department of Natural Resources.

6. The director upon advisement of the State Board of Health and the Division of Fish and Wildlife does or does not request the State Attorney General's office to seek reimbursement from the polluter for fish loss. Value of fish determined by cost of replacement from commercial source.

7. Upon receipt of payment, money used to restock water where fish were killed.

FISH KILL INVESTIGATION PROGRAM
VIRGINIA STATE WATER CONTROL BOARD

The Virginia State Water Control Board operates as a separate agency regulating Virginia's water pollution problems. The Water Control Board is responsible for water quality, while the Health Department regulates public health matters and the Virginia Commission of Game and Inland Fisheries controls fish and wildlife regulations. The agency consists of approximately 106 people divided in three divisions for enforcement, pollution abatement, and technical services. The Technical Services Division has its own complete chemical and biological sections and is capable of performing almost any water or tissue analyses. A certified fisheries pathologist is also on the staff. During 1970, the staff investigated 89 fish kills and 154 pollution complaints (not involving fish kills). The development of 7 day a week 24 hour hazard alert teams (HATS) has increased our response tremendously to fish kills and pollution complaints. Operating on a rotating week basis, these 7-8 man teams investigate as soon as notification is received, no matter what day or time. Each team is composed of at least one biologist and chemist. The value of immediate investigation by qualified personnel can not be overstated. The HATS team, through co-ordination with the State Police, major industries, and other State and Federal agencies, has enabled Virginia to effect immediate action on fish kills without delays due to personnel or equipment. Members of the Board's staff do not have arresting power, although any authorized agent of the Board may, at reasonable times and under reasonable circumstances, enter any establishment or property for the purpose of conducting surveys or investigations necessary to enforce the Water Control Board Law. All

discharges are certificated by the Board and emergency orders may be imposed in cases constituting serious hazards to water quality. In 1970, a total of 17 fish kills, valued at $16,417.72, were found to be caused by pollution; as of February 1971, 4 cases have been settled for a total of $7,654.13 and 7 more cases are pending. The State of Virginia recovers for both the costs of the dead fish and the cost of the investigation.

Summary of Remarks by David W. Robinson at the Fish Kill Investigation Seminar, January 13, 1971.

Responsibility of fish kill investigation in West Virginia falls with the Director of the Department of Natural Resources. Three divisions within the Department (Water Resources Division, Wildlife Resources Division, and Law Enforcement Division) are primarily concerned.

As standard procedure, fish kills receive highest priority within the Department and all Department personnel are advised to make immediate reports of fish kills in their area and to stand by to aid in the field investigation if necessary. Upon varification of a fish kill by local Conservation Officer or departmental employee, district and headquarter personnel of the Water, Wildlife, and Enforcement Divisions are notified and a coordinated investigation is begun. Standard forms and investigating procedures are followed.

When the cause can be determined, the Director requests payment for loss of fish and aquatic life as required by State Law. The assessment for the fish loss is made by fishery biologists, and is based on the commercial value of the fish involved in the kill. The Pollution Committee of the Southern Division of the American Fisheries Society's "Monetary Values of Fish" has been adopted and will be used as the reference source for fish kill assessments. The largest assessment for a West Virginia fish kill made to date was approximately $43,000. All funds collected from fish kill assessments are placed in a special aquatic life fund, which by State Law must be used to purchase fish for restocking in State waters.

DAMAGE ASSESSMENTS: VALUES OF FISHES

by

Daniel Sherry

Abstract of Talk Given by Daniel Sherry
At Fish Kill Investigation Seminar

Title: Fish Kill Damages; Monetary Values of Fishes

Background summary of the activities of the southeastern states in fish kill damage recovery and monetary fish values was given. In 1966, Monetary Values of Fishes by John M. Stubbs was published by the Tennessee Game and Fish Commission. This document based fish values on those obtained by averaging returns from questionnaires to all states and Canada. The main disadvantage to the values was the lack of sound basis for the figures returned by these participating states. In 1970, the Southern Division of the AFS adopted a new set of values intended as a guideline for all of the southeastern states. Hatchery values were used when possible for a basis of value, but other considerations had to be used both objectively and subjectively for species not artificially propagated. These included commercial value, value to fisherman, aesthetic value, ecological value, and relative abundance (for rare species). Other factors not used in formulating the southeastern values were mentioned as possible considerations. The need for developing monetary values for supporting habitat was pointed out.

A history of the use of monetary values in making damage assessments in Tennessee was given. Claims have been made regularly for 2 1/2 years. Tennessee has no specific authority to make these claims but authority is assumed through a basic law charging Game and Fish with the protection of fish and wildlife, claiming them property of the state when in public waters. Thirty claims ranging from $50 to $20,000 each have been made. None have been lost as yet; none have been to court; several of the more recent cases are still pending. Expenses are claimed in addition to the fish value. Claims are made against industries, municipalities and individuals with no preferential treatment. Cases involving industries have been generally easier to settle, those involving individuals harder.

MONETARY VALUES OF FISH

Species	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"	13"	14"	15"	16"	Price Per Fish	Price Per Lb.
Largemouth Bass	.20	.25	.35	.50	.65	.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.25						$2.50/12"
Smallmouth and Spotted Bass	.25	.50	.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.25	$2.50	$2.75	$3.00						$3.50/12"
Sunfish (Bluegill Redear, etc.	.10	.15	.20	.25	.35	.60	$1.00	$1.25	$1.75	$2.50								$3.00/10"
Crappie Black and White	.10	.15	.20	.30	.40	.50	.60	.75	$1.00	$1.25	$1.50	$2.00						$2.50/12"
Walleye and Sauger	.30	.40	.50	.60	75	$1.00	$1.25	$1 50	$1.75	$2.00	$2.25	$2.50	$2.75	$3.00	$3.25			$4.00/15"
Blue Channel & Flathead Catfish	.02	.03	.04	.05	.07	.10	.12	.15	.20	.25	.30	35	.40	.50	.60			$1.00/15"
Bullheads	.02	.03	.04	.05	.07	.10	.12	.15	.20	.25	.30	35						$0.35/12"
Striped Bass	.25	.50	.75	$1 00	$1.25	$1.50	$1.75	$2.00	$2.25	$2.50	$3.00	$4.00	$5.00					$5.00/13"
White and Yellow Bass	.10	.15	.20	.30	40	.50	.60	.75	$1.00	$1.25	$1.50	$2.00	$2.50					$2.50/13"
White Perch	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60						$0.60/12"
Yellow Perch	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60						$0.60/12"
Rock Bass	.25	.35	.50	.75	$1.00	$1.25	$1.75	$2.25	$2.75	$3.50								$3.50/10"
Muskellunge	.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.50	$3.00	$4.00	$5.00	$6.00	$7.00	$8.00	$10.00				$10.00/14"
Northern Pike	.25	.50	.75	$1.00	$1.25	$1.50	$1.75	$2.00	$2.25	$2.50	$2.75	$3.00	$3.25	$3.50				$3.50/14"
Carp	.05	.05	.05	.05	.05	.05	.10	.10	.10	.15	.15	.20						$0.20/12"
Suckers--Redhorse	.05	.05	.05	.10	.10	.10	.15	.15	.20	.20	.25	.30						$0.30/12"
Drum	.05	.05	.05	.10	.10	.10	.15	.15	.20	.20	.25	.30						$0.30/12"
American and Hickory Shad	.10	.10	.10	20	.20	.20	.30	.40	.50	.60	.70	.75						$0.75/12"
*Other Shad	.02	.02	.02	.04	.04	.04	.06	.06	.08	.08	.10	.10						$0.15/12"
Alewife & Herring	.10	.10	.10	.20	.20	.20	.30	.40	.50									$0.50/9"
Gar All Species	.02	.02	.02	.04	.04	.04	.06	.06	.08	.08	.10	.10	.10	.15	.20	.25		$0.25/16"
Bowfin	.02	.02	.02	.04	.04	.04	.06	.06	.08	.08	.10	.15	.25					$0.25/13"
Buffalo	.03	.03	.03	.03	.06	.06	.10	.10	.10	.15	.20	.25						$0.25/12"
Carp Suckers	.02	.02	.02	.04	.04	.04	.06	.06	.08	.08	.10	.10						$0.15/12"
Paddle Fish													ALL SIZES					$0.50
Eel (American)													ALL SIZES					$0.50
Eel (Lamprey)																	.05	
Sturgeon													ALL SIZES					$50.00
Salmonidae	.06	.08	.10	.20	.25	.30	.35	.40	.45	.55	.75	$1.00	$1.20	$1.40				$1.40/14"
Pickerel	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.75	$1.00	$1.50	$2.00	$2.50	$3.50		$3.50/16"
* Bait Fishes		$30.00 / 1000 Fish																
Other Fishes										MUGILIDAE ALL SIZES								$0.30
										COTTIDAE							.10	
										PERCIDAE (Darters)							.10	
										ICTALURIDAE (Madtoms)							.10	
										SOLEIDAE							.10	
										APHREDODERIDAE							.10	
										CHARACIDAE							.05	
										CICHLIDAE								
										Rio Grand Perch							.02	
										Tilapia							.25	

* Other Shad - Gizzard, Threadfin, Mooneye, Skipjack, Menhaden, Goldeye

* Bait Fishes - Cyprinidae, Cyprinodontidae, Poeciliidae, Umbridae, Engraulicie, Atherinidae

MONETARY SETTLEMENTS FOR FISH KILLS

Tennessee Game and Fish Commission
1967 - 1969

Date of Fish Kill	Body of Water	County	Pollution Source	Type Kill	Number Fish Killed	Amount Requested	Amount Received to Date*
June, 1967	Clinch River	Hancock	Appalachian Power Co.	Industry	54,567	$18,616	$15,655
July, 1968	Nolichucky River	Hamblen-Cocke	American Enka Corp.	Industry	1,944	347	347
Aug., 1968	Cumberland River	Davidson	DuPont	Industry	175,464	11,729	11,729
Aug., 1968	Ewing Creek	Davidson	Parkwood	Sewage	13,114	326	326
Sept., 1968	Hiwassee River	McMinn-Bradley	Olin-Mathieson	Industry	7,501	2,034	2,034
Oct., 1968	Beaver Creek	Sullivan	Bassett's Dairy	Food Proc.	675	101	101
Oct., 1968	Cumberland River	Davidson	Metro Nashville	Sewage	7,001	870	700
				Totals for 1968	205,699	$15,407	$15,237
May, 1969	Wolf River	Shelby	City of Memphis	Sewage	7,572	307	250
May, 1969	Little Pigeon River	Sevier	Activated Metals Corp.	Industry	2,000	816	816
July, 1969	Wolftever Creek	Hamilton	McKee Bakery	Food Proc.	5,808	1,921	861
July, 1969	Knob Creek	Washington	Metals Engineering	Industry	2,710	664	664
Aug., 1969	Beans Creek	Franklin	Randall Owens	Ag. Pesticides	73,712	4,386	Pending
Oct., 1969	East Fork Stones R.	Cannon	City of Woodbury	Water Treatment	1,346	49	49
Oct., 1969	Mill Creek	Davidson	Radnor Utility District	Sewage	918	223	223
				Totals for 1969	94,066	$ 8,366	$ 2,863
				GRAND TOTALS	354,332	$42,389	$33,755

* Table prepared January 5, 1971

MONETARY SETTLEMENTS FOR FISH KILLS

Tennessee Game and Fish Commission

1970

Date of Fish Kill	Body of Water	County	Pollution Source	Type Kill	Number Fish Killed	Amount Requested	Amount Received to Date*
Jan., 1970	Shoal Creek	Lawrence	Murray-Ohio Bicycle Co.	Industry	111,397	$25,666	$20,000
May, 1970	Big Bigby Creek	Maury	Mobil Chemical Co.	Industry	3,366	1,171	1,171
May, 1970	Caney Creek	Roane	City of Harriman	Sewage	3,267	1,125	1,125
May, 1970	E. Piney & Piney R.	Dickson	City of Dickson	Sewage-Industry	82,224	6,415	6,415
May, 1970	S. Indian Creek	Unicoi	Lemon Trucking Co.	Transportation	27,664	1,134	Pending
June, 1970	Duck River	Maury	Hooker Chemical Co.	Industry	762	285	285
June, 1970	Cove & Walden Creek	Sevier	Tarwater Chicken Farm	Feed Lot	23,432	2,280	Pending
July, 1970	Big Bigby Creek	Maury	Stauffer Chemical Co.	Industry	99,236	716	716
July, 1970	McKellar Lake	Shelby	City of Memphis	Sewage	58,714	547	Pending
Aug., 1970	Mill Creek	Davidson	Radnor Utility District	Sewage	3,047	543	Pending
Aug., 1970	Stones River	Rutherford	City of Murfreesboro	Sewage	19,545	10,220	Pending
Aug., 1970	Little Bigby Creek	Maury	Phelps-Dodge Co.	Industry	14,225	510	Pending
Sept., 1970	Trace Creek	Humphreys	City of Waverly	Sewage	29,057	2,356	Pending
Sept., 1970	McKellar Lake	Shelby	City of Memphis	Sewage	100,100	2,315	Pending
Oct., 1970	Horse Creek	Sullivan	Slip-Not Belting Co.	Industry	1,676	284	284
Oct., 1970	Mill Creek	Davidson	Radnor Utility District	Sewage	558	357**	
				Totals for 1970	578,270	$55,924	$29,996
				GRAND TOTALS	932,602	$98,313	$63,751

* Table prepared January 5, 1971
** Claim not yet filed.

OTHER ECONOMIC DAMAGES

by

Donald LaPointe

OTHER ECONOMIC DAMAGES*

A fish kill is one result of a problem affecting a water resource. Many other adverse results may occur. These results are difficult or, in many instances, impossible to measure, especially monetarily.

When a fish kill occurs, monetary values usually can be assigned only to those species which are commercial -- those which are bought or sold for food, bait, or stocking. Other species which are important ecologically but have no commercial value are either lumped with those that have value or are disregarded. In addition, other species of animals and plants which are affected are often overlooked. In some instances, other values lost, such as recreational use not related to the biota, aesthetic considerations, and other intangible values are not included. All of these are integral parts of the water resource value.

The monetary value of the water resource itself may be more easily determined than the value of the fish killed and also, may better represent the loss. This value is the sum of the values of potential uses (which are tangible and can be measured monetarily) and the intangible values related to the protection and preservation of the resources. Please note that I said, "potential". I will discuss this later.

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*Talk given by D. F. LaPointe, Associate Regional Supervisor, Division of River Basin Studies, Region 3, Bureau of Sport Fisheries and Wildlife, at the Fish Kill Investigation Seminar, Cincinnati, Ohio, January 12, 1971.

Tangible uses include such things as hunting, fishing, swimming, boating, water skiing, and many other forms of recreation. The magnitude of these uses is first determined in man-days and then these are converted to monetary values.

Man-days use may be determined by actual counts, by sampling, or by various methods of estimation.

Contrary to popular belief, the monetary value of a recreation day is not equivalent to the cost associated with the experience. Rather, the value is the profit (or that amount which a private operator could net each man-day of use).

The daily value for a particular area, then, is the value of a recreation day multiplied by the number of man-days expended on the area.

Intangible values are much more difficult to define monetarily. They include such things as the protection of wild and primitive areas, areas of unique beauty, areas of scenic, historical and scientific interest, and the preservation of rare and endangered species and their habitat.

Monetary values for some of these intangibles might be estimated using a cost necessary to protect the intangible and assuming a benefit-cost ratio of 1::1 or by using the single-purpose alternative method. In this latter method the cost of developing a similar area is equal to the value of the area in question.

Now I'd like to go back to one of my opening statements where I said that the value of the water resource should be determined by its "potential" uses. Potential uses should be used in evaluating since we should have a goal in mind for any specific area. The fact is -- we do have defined goals in most instances. These are described in State water quality standards for interstate waters. Many States also have standards for intra-state waters. These standards prescribe the uses of each water area in addition to the water quality criteria for each area.

We should not condone the use of existing uses in determining values since many of our water resources already are degraded to the point where use is limited. For example, an industry causing a fish kill in an already polluted area probably would be liable for only a very small loss (if the loss was determined by the kill) when in reality the goal for that area might be quite high in value.

In the past, returns of losses by offenders (fines or claims) were often used for restocking. This, in many instances, was regrettable, since migration into the area and natural restocking begins almost immediately. Although, at times, restocking may be necessary, these funds probably could be used to better advantage for research on methods to prevent kills or to determine the effects and extent of the problem.

There is one more point I'd like to make. Fines do not necessarily have to be commensurate with the loss. Fines are meant to be a deterrent to the breaking of a law. They do not compensate for the loss. Prevention of the loss is a much better method to protect and preserve our natural resources.

II. NATURAL FISH KILLS

Moderator: Dr. Richard Tubb

FIELD SAMPLING FOR PARASITES

by

Dr. Wilbur Tidd

Method of Collecting Parasites

Wilbur M. Tidd

Ohio State University

I wish you to consider briefly a few points about parasites:

1. Wild fishes are always a potential source of parasites. When such fish become isolated in flooded areas or used to stock ponds their parasites may increase to great numbers. This is the common type of epidemic we encounter.
2. In open lakes and rivers fish kills due entirely to parasites are not frequent. When these conditions are encountered, make certain you have not overlooked some other contributing cause.
3. Stresses placed upon non-parasitized fish populations, which by themselves will not produce a kill, will sometimes prove fatal to fish already stressed by parasites. We have encountered this condition in handling muskellunge fry. All those lost carried female Lernaea cyprinacea, while all non-parasitized ones survived.
4. Lessions upon the gills or body surface produced by parasites destroy protection provided by mucus and skin. These lessions are sometimes invaded by bacteria and fungi.

Preparation for collecting parasites

In our laboratory we keep a kit handy at all times. It includes a standard dissecting set, hand lens, formalin, vials, labels, rubber bands, a towel, and several heavy-duty plastic bags. These bags make excellent containers in which to transport our fish. Our kit also includes a plastic foam ice chest. Parasitologists perfer to collect parasites and evaluate

damage from fresh rather than perserved fish.

Work at the site of a fish kill

Visit the fish kill immediately after you are notified. Often delays in visiting kills result in little or no data being collected. First, check the fish still surviving. I would collect thirty of these, if possible, and later ice them. The dead fish should be counted and the species determined. A sample of these should also be taken. The collector will have to use his discretion as to whether these should be opened and preserved in 10 percent formalin or iced. The physical state of the fish will regulate this.

After samples are collected, a field examination of the external surface and gills should be made. Several fish should be opened and the internal organs observed. The data thus obtained should be entered in a field book, the samples iced and rushed back to the laboratory.

References

I would advise those who may have to identify parasites to have available a copy of Parasites of North American Fresh Water Fishes, by Glenn L. Hoffman. This was published in 1967 by University of California Press, Berkeley and Los Angeles. There is also an excellent series of leaflets from the Eastern Fish Disease Laboratory, P. O. Kearneysville, West Virginia 25430.

For help in identification of specific parasites I am advised that for hatchery problems Lyle Pettijohn, National Fish Hatchery, Kearneysville, West Virginia 25430, can assist you. For gross determinations which you cannot make yourself I am advised you can probably get help from James Warren and Howard Jackson at Genoa, Wisconsin, or James Camper, Pisgah, North Carolina. The Zoology Departments of your state universities can be helpful. Please contact these people before sending them parasites.

FISH DISEASES AND RELATIONSHIP TO FISH KILLS

by

Dr. Glenn Hoffmann

Fish Diseases and Relationship to Fish Kills*

Glenn L. Hoffman
Eastern Fish Disease Laboratory
Bureau of Sport Fisheries and Wildlife
U. S. Department of the Interior
Kearneysville, West Virginia 25430

*Presented at the Fish Kill Investigation Seminar, Cincinnati, Ohio, January 12-14, 1971.

INTRODUCTION

Fish kills caused by fish diseases are usually difficult to diagnose because, so far, it has been mostly by chance that a properly trained scientist has been available at the place of the kill. There is probably no one person who is properly trained sufficiently in all aspects of fish diseases to enable him to diagnose kills caused by bacteria, viruses, or parasites, let alone causes of other nature.

When a fish kill occurs, it is my opinion that a team approach should be available. The team should consist of people who specialize in one of the following disciplines: toxicology, histopathology, bacteriology, virology, and parasitology.

In human and veterinary medicine the cause of death in previously undiagnosed cases is often determined by a complete autopsy by a pathologist with the assistance of a histopathologist, virologist, bacteriologist, and parasitologist, if needed. There is no reason to believe that fish disease diagnosis could not be done similarly.

In the United States assistance in fish disease diagnosis is presently available from state personnel in the states of Maine, New York, Michigan, Alabama, Mississippi,

Ohio, Utah, Virginia, Texas, Pennsylvania, Illinois, North Carolina, New Jersey, Missouri, Colorado, Wisconsin, Minnesota, Wyoming, Idaho, California, Oregon, and Washington. National fish hatcheries have first choice in assistance from federal fish disease scientists who also may aid states and private enterprise. The federal facilities consist of two fish disease research labs, located at Kearneysville, West Virginia, and Seattle, Washington. In addition there are National Fish Hatchery Biologists located at Cook, Washington; Leavenworth, Washington; Ahsahka, Idaho; Anderson, California; Springville, Utah; Tishomingo, Oklahoma; Genoa, Wisconsin; Pisgah Forest, North Carolina; Stuttgart, Arkansas; Kearneysville, West Virginia; East Orland, Maine; and Lamar, Pennsylvania.

The federal fish disease research and diagnostic service has become quite similar to that of Public Health and Veterinary Medicine and works quite well although still greatly understaffed. It is my opinion that this service should continue to be expanded as the need develops.

The above services will help fish kill laboratories if needed, I'm sure, but it is my belief that "on the spot" personnel would better benefit such labs. Therefore, I suggest that fish kill labs consider establishing fish disease researchers at their central labs with personnel similar to the Fish Hatchery Biologists located at the regional labs.

At present, training in fish disease diagnosis is available at the Eastern Fish Disease Laboratory, Kearneysville, W. Va.; Auburn University; Mississippi State University; New York Aquarium; University of Washington; Colorado State University; Fresno State College (California); and Oregon State University. Guelph University and Texas A and M are hoping to establish fish disease courses.

In addition to diagnosing directly the cause of mortality of fish in fish kills, fish kill laboratories use fish for the bioassay of suspect polluted waters and in research on the effect of toxic agents on fish. These test fish should be disease-free; fish disease experts should be available to guarantee that no dangerous disease agents are present to interfere with the testing.

Previous speakers at this seminar have given us estimates of the value of our wild fish. Truly they are a valuable resource. The damage done to such fish by disease agents ranges from fish kills to no obvious deleterious effect with all in-between situations. Therefore, it would seem logical that fish diseases in nature should be studied so that eventually we might be able to control epizootics in nature. Certainly when dangerous disease agents are found in fish such fish should not be transferred to where there are non-infected stocks of fish.

VIRUSES AS AGENTS OF FISH KILLS

Because of the late development of fish virology it is entirely possible that there have been fish kills caused by viruses that were never diagnosed. As far as I know the contagious stomatitis virus disease of S. African characinids is the only one documented as causing fish kills in nature (Wolf, 1966). Recent evidence indicates that the English ulcerative dermal necrosis is caused by a virus. The fish kills from this disease, however, are not as spectacular as that caused by toxic materials. The ulcerative lesions are distinctive enough to rule out toxicity, as far as is known.

Of the 15 known fish viruses (Wolf, Ken, 1966) and except for the above, none have been implicated in fish kills in nature but in my opinion those which are agents of acute disease (IPN and Egtved of trout, sockeye and chinook salmon virus, contagious stomatitis of S. African characinids) could certainly cause an epizootic in nature if contamination were placed in a susceptible population, particularly of fry.

Diagnosis could be made using methods outlined by Wolf (1970). This involves histopathology (formalin preserved specimens are satisfactory -- use moribund fish) and inoculation of tissue culture. The latter method involves fresh specimens, the fresher the better, but

frozen material is a second best. IPN virus, however, is the only known one which will survive storage in 50% glycerine.

It is not likely that the non-acute virus diseases (lymphocystis, walleye sarcoma, walleye epidermal hyperplasia, papillomas, and "cauliflower" disease) cause extensive fish kills, however, only lymphocystis has been studied experimentally. There is a possibility that there are early acute phases of these which could cause kills before the typical visible symptoms develop. Further, the debilitating effects of any disease may contribute to factors causing a fish kill. Multiple causes of a fish kill might make diagnosis extremely difficult and are probably more common than is realized.

BACTERIA AS AGENTS OF FISH KILLS

As with many other infectious agents, infected stocks of fish may range from near normal, through various degrees of chronic disease to acute disease with numerous mortalities. Fish kills in nature by bacteria are not well documented because fish bacteriologists have seldom been available at the time of the kill.

METHODS

Only affected but living fish should be collected. Bacterial examination must be made within one hour after the death of the fish. Any suspicious lesions should be examined and cultured. A kidney culture should always be made because, although this may not be the site of primary infection, many bacteria are filtered out in this organ. Bacterial penetration in dead fish may be very rapid and such fish can not be trusted for bacterial culturing. Unless the symptoms clearly indicate a very specific bacterial disease, many culture media must be inoculated -- Leetown No. 8, Trypticase Soy Agar, Ordal's columnaris medium (Bullock, 1961). Kidney smears, as well as smears from any suspected lesions, should be stained with Gram's stain and Mycobacterium acid-fast stain.

Documented Bacterial Epizootics

Listed here are a few examples:

1. Aeromonas Diseases

   During the summers of 1967 and 1968, Aeromonas liquefaciens was involved in disease of Salmo salar and Catostomus commersoni in the Meramichi River,

New Brunswick. A surge of copper and zinc pollution in late June 1967 and high river temperatures enhanced the conditions for an epizootic. The epizootic recurred in 1968. Symptoms were typical -- necrotic skin lesions. (Pippy and Hare, 1969).

2. Furunculosis

Furunculosis diseased trout were stocked in a stream and soon afterward dying suckers and minnows were seen. (Snieszko, unpubl. 1956).

3. Pseudomonas sp.(a prev. non desc. sp.)

Thousands of dead perch. Dailey Lake, Montana. Many petechiae external and in dorsal musculature; peritoneal cavity inflammation with bloody ascitic fluid. (Ross, et al., 1960).

4. Columnaris disease (Chondrococcus columnaris)

"Since 1944 numerous outbreaks of columnaris disease have been reported in both natural and hatchery populations of fish" -- including warmwater fishes as well as salmonids.

Also discussed were differences in virulence of different strains and the condition of fish influenced by stress caused by malnutrition, temperature, gases, toxins, and other pathogens. (Pacha and Ordal, 1970).

5. Fish Mycobacterium

During the period from about 1952 to 1960, ground raw marine fish were fed to western U. S. salmon in fish hatcheries; fish mycobacteriosis became very prevalent. The following is quoted from Ross (1970).

"It was difficult to assess the magnitude of damage experienced by salmon populations but from the high incidence seen in adult migrants, it must be assumed that a considerable mortality occurred at sea."

6. Vibrio Disease

"Vibrio disease occurs as epizootics in wild and captive populations of marine fish and migratory species such as eels and salmonids" (Anderson and Conroy, 1970). The main symptoms are those of ulcerative hemorrhagic septicemia.

To culture Vibrio anguillarum one must add 1.5 to 3.5% NaCl to media.

Cisar and Fryer (1969) reported an epizootic in juvenile chinook salmon reared in salt water impoundment on the Oregon coast.

7. Pasteurella sp.

Snieszko et al. (1964) stated: "Epizootic started in late June (1963) in the Potomac estuary and spread during the summer to widely separated

locations. In addition to white perch (Roccus americanus), striped bass (R. saxatilis) were involved to a lesser degree." For culturing, one must add one (1) to three (3) percent NaCl to the agar media.

8. Dexter, Roger (1970, pers. comm.) reported yellow perch mortalities in Baker Lake and Moosehead Lake, Maine Apparently no other fish were affected. Bacteria were isolated but not identified.

9. Unclassified

Bullock and Snieszko (1969) found that potential epizootics were found present in apparently healthy hatchery trout -- 12 to 26% of trout positive for bacteria. Stress would probably convert this to an epizootic.

10. Lucier, C. (1970, pers. comm.) found lake trout, whitefish, grayling, longnose suckers dead and dying in Crosswing Lake (Copper R drainage) Alaska. There were fungus-like growths on the fins of 3-4 lb. fish. Only frozen and preserved specimens were studied and the bacteria were not identified.

Bacteria -- Summary

Snieszko (1964) in a discussion of bacterial epizootics states that epizootic bacterial diseases are influenced by:

(1) Immunological resistance

(2) Genetic resistance

(3) T° stress

(4) Pollution

(5) Unfavorable water chemistry

(6) Other unfavorable environmental conditions.

I would like to add here that it is not always easy to determine the cause of death when multiple factors are involved.

FISH KILLS CAUSED BY ALGAE

1. Toxic algae

Certain species of algae produce toxins which may kill fish, and some are also toxic to mammals which drink water containing the toxin. Such occurrences could easily be mistaken for direct pollution kills. This is not a complete review, but listed here are some examples:

A. Canada

Smirnov and Feokistova (1963) reported on toxicity of the blue-green algae, Coelosphaerium dubium in British Columbia.

B. Israel

Blooms of Prymnesium parvum (a flagellate), certain blue-green algae, and possibly others killed fish in carp ponds (Shilo, 1965; Ulitzur, 1966; Sarig, 1966; Dafni, 1964).

The toxic blue-green algae, Microcystis, Anabaena, Spirulina and Oscillatoria killed fish and some were toxic to livestock (Shilo, 1964).

C. U. S. S. R.

Komarovsky (1970) reported on pathological changes due to the toxicity of Cyanophyta.

D. Japan

Matilda et al. (1967) reported a fish kill caused by the toxic gymnodinuim, Glenodinium in a reservoir.

E. Marine

"Red tide" caused by certain dinoflagellates has caused fish kills.

F. U. S. A.

In earthen ponds at the Leetown National Fish Hatchery about 1964 there was a fish kill of rainbow trout for which no infectious disease or pollution could be found. We assumed that it was caused by

toxic algae. In addition to death, the most obvious symptom was that of the fish trying to escape from the pond; some jumped out of the pond onto the bank.

2. Oxygen depletion caused by algae

United States

Swingle (1968) discussed fish kills due to oxygen depletion by excessive algal growth. Microcystis was the most common cause of such kills. Copper sulfate was used for control.

PARASITES IN FISH KILLS

There are many species of North American freshwater fish parasites -- about 1,000 listed in Hoffman (1967). Some cause no detectible damage to fish in nature, some kill fish and there are all degrees between the two extremes.

In addition to the inherent ability of the parasite to cause a certain type or degree of harm, it is also under the influence of the total environment (ecology) and its population is determined by at least the following factors:

1. Species of fish. Some parasites are very host specific, others not.
2. Space relationship of fish.
3. Water currents -- gravity flow; wind induced.

4. Water quality -- temperature, toxicity, dissolved gases.
5. Relationship with other parasites.
6. Condition of fish -- nutrition.
7. Previous exposure -- possible partial immunity.
8. Presence or absence of necessary intermediate hosts. This might involve the total ecology.
9. Season -- Circadian.

Therefore, one can expect to find everything from no apparent effect to dramatic epizootics resulting in "fish kills". The stress of severe parasitism may also accelerate toxic fish kills and vice versa.

It is my opinion that no single person is qualified to diagnose the cause of fish kills. I'm certain that the best work on fish kills will be that done by a team -- toxicologist, bacteriologist, virologist, histopathologist, and parasitologist. Even if there is circumstantial evidence indicating a pollution kill, all aspects should be considered. One might visualize a central lab staffed with highly experienced scientists in these divisions. Regional labs might be staffed with personnel with adequate training for very important collecting who can forward properly prepared material to the central lab.

Assistance in identification of the parasites can be found in Hoffman (1967).

METHODS

The best fish to examine are those which are alive, but moribund, the next best are those which have just died. Those preserved in 10% formalin are third best.

A. Small fish

(1) External. Examine in water under 10 X diss. scope. Remove opercula to examine gills. Examine pieces of fins, skin scrapings and gills under 100 X and 450 X.

(2) Internal. Dissect in 0.85 saline under 10 X scope. Examine all organs!

B. Larger fish

As above, but examine parts of the fish under the diss. scope.

RECORDS OF FISH KILLS CAUSED BY PARASITES AND SOME POTENTIALS

Fungi

1. Saprolegnia and relatives.

I have heard of badly infected fish and mortalities following spring spawning runs. No documentation.

2. Ichthyophonus hoferi.

Caused severe epizootics of marine fish (herring) (Sindermann, 1958). It is believed that this parasite could build dangerous populations in natural fresh waters. It caused such severe disease in one trout hatchery that the hatchery had to close.

Protozoa

1. Ichthyophthirius multifiliis.

Probably the greatest cause of freshwater parasitic epizootics because of inherent pathogenicity and no host specificity.

Elser (1955) reported a kill of perch in Deep Creek Lake, Maryland.

Hopkins, C. A. (1959) reported a kill of stickleback in England.

Kudo (1934) reported a kill of carp in a reservoir, Peoria, Illinois.

Goede (unpubl., 1967) reported that spawning dace but not trout were killed in Montana Reservoir, Brigham City, Utah.

Goede (unpubl., 1967) reported that spawning Utah chub but not trout were killed in Koosharem Reservoir, Utah.

U.S.F.H. Report (1967) reported a kill of flannelmouth suckers and silver dace.

Allison and Kelly (1963) reported an extensive fish kill in the Coosa River system of Alabama. Many species of fish were affected.

2. Ceratomyxa shasta.

Sanders and Fryer (1970) discuss the distribution in Columbia drainage. Fish exposed to reservoir water contracted the disease readily.

3. Myxidium oviforme.

Shulman and Shulman-Albova (1953) reported that the surface of liver of moribund salmon was covered with red pustules containing the parasite. POTENTIAL.

4. Myxobolus cyprini.

Shulman (1962) reported viscera of carp, tench and bream were heavily infected resulting in anemia and death of fish.

5. Myxobolus exiguus.

Shulman (1966) discussed gills of cyprinids heavily infected. Hemorrhage and possible "asphyxiation" mortalities.

6. Myxobolus koi.

Hoshina (1952), Japan. Reported 50,000 four (4) month old carp killed during September and October. In gills. Red "tumors". POTENTIAL.

7. Myxobolus pfeifferi.

Europe, "boil disease" of cyprinids. Most infected fish die, April - October. (Shulman, 1966).

8. Myxosoma cerebralis.

Infected young fish probably do not survive in nature. POTENTIAL for salmon and natural trout spawning. In our recent experiments at Leetown we produced all degrees of disease from no effect to mortalities by varying the number of spores present in the aquaria. Survivors of severe disease were 37% as large as the controls. Survivors of moderate disease were 80% as large as controls.

9. Thelohanellus piriformis.

Mass destruction of Coregonus spp. in a tributary of the Ob (N.W. U.S.S.R.) (Volkova, 1941; Bauer, 1948; Petrushevskii and Shulman, 1958). (Quoted in Kudo and Meglitsch, 1971).

10. Other myxosporidia.

Plehn (1924) in Kudo and Meglitsch (1971), reported loss of 100,000 lbs. of Barbus in Neckar River.

Williams, H. H. (1964) in Kudo and Meglitsch 1971, Thelohanellus caused mass mortality of R. rutilus, England.

11. Microsporidea.

Putz, Hoffman and Dunbar (1965) reported mortality of gizzard shad, Charles Mill Reservoir, Ohio.

Glugea of marine and brackish waters, also smelt, in Maine and Great Lakes.

12. Monogenetic trematodes.

Gyrodactylus caused the death of sticklebacks under crowded conditions and Nitzschia sturinois caused serious depletion of sturgeons when introduced into the Aral Sea (Petrushevski and Shulman, 1958). Others -- POTENTIAL.

13. Cercariae.

Styczynska (1959), Poland, placed fry in live cages 35 ft. from shore -- fry were killed by cercariae. This is probably fairly common in shallow bays where large numbers of snails and fish congregate. POTENTIAL. Much experimental evidence of mortalities caused by other cercariae. (Hoffman 1954, 1956, 1958; Hoffman and Hundley, 1957; Hoffman and Dunbar, 1963; and others).

14. Metacercariae.

Eye flukes (Diplostomulum) -- Causes blindness. POTENTIAL.

Visceral -- usually no dramatic epizootic but may contribute to kills by other agents.

Heart -- Ascocotyle in heart of Gambusia; Bucephalus -- deKinkelin (1968). France.

Postodiplostomum minimum in striped bass (wrong host) caused mortalities -- POTENTIAL; this could happen in nature.

15. Cestodes.

Diphyllobothrium larvae in hearts killed adult Coregonus clupeaformis (Moore, 1925, 1926) in New York. Also in brook trout at Three Rivers, Quebec. POTENTIAL.

Ligula and Digramma caused kills in reservoirs in U. S. S. R. (Bauer, 1970).

16. Nematodes.

Bauer (1970) reported Raphidascaris acus larvae caused mass mortality of bream in 1970 in U. S. S. R.

Others -- POTENTIAL. Possibly Contracaecum.

17. Acanthocephala

No documented fish kills. An unusual surge in acanthocephalan populations could probably cause mortalities. POTENTIAL.

9-1<

18. Leeches.

Rupp and Meyer (1954) reported an unusual fish kill of brook trout in Oquossoc Lake, Maine.

19. Parasitic Copepods.

A. Lernaea cyprinacea -- Grand Forks, North Dakota, about 1956 (personal observation). Sigler (unpubl.) -- Utah. Tidd (preceeding talk).

B. Argulus biramosus -- two severe epizootics in South Dakota, (Allum and Hugghins, 1959). Ghittino of Italy told me about an Argulus that could paralyze a fish with one sting from one parasite.

C. Ergasilus arthrosis (E. lizae) - Lake Shelby, Alabama. Caused much damage to Lepomis macrochirus, L. microlophus and Micropterus salmoides, (Kelly and Allison, 1962).

D. Ergasilus sieboldi -- very common cause of fish kills in Europe.

E. Glochidea -- Murphy (1942) Margaritifera m. falcata.--Truckee R. California 1931-1936, high mortality of fry (June-August). Hatchery received stream water, so wild fry must have been exposed to the same problem.

Locke (1966 personal communication). Have to use screens at Oquossoc Hatchery (near Rangely L.) during glochidea season.

SUMMARY

Fish diseases and parasites have caused fish kills and are suspect contributors to kills caused primarily by other agents.

It is important that fish be examined alive, or only very recently killed, by a trained fish disease specialist. Preserved specimens can sometimes be used but are not as satisfactory as living material.

The team approach to diagnosing fish kills is recommended -- toxicologist, histopathologist, bacteriologist, virologist, and parasitologist.

Although definitive diagnosis can not always be made with histopathologic techniques, such techniques can reveal the organs involved and often indicate the general type of damage.

Fish used in toxicological research and bioassay should be disease-free. If native fish from above the polluted area are used for bioassay, they should be examined for infectious agents; disease-free fish should be used as replicates of the test.

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III. TOXICANT CAUSED FISH KILLS

Moderator: Charles E. Stephen

Introduction

by

Charles E. Stephen

FISH KILL INVESTIGATION SEMINAR

Session III. Toxicant Caused Fish Kills

Part 1. Introduction

Charles E. Stephan

The purpose of this session to discuss what it takes to determine if a fish kill was caused by a toxicant and, if so, what was the toxicant. I think evidence concerning fish kills basically falls into three categories:

(1) On-site evidence collected during the on-site investigation at the scene of the fish kill as soon as possible after the fish kill, including the routine analysis of water samples collected during the on-site investigation.

(2) Miscellaneous evidence collected by various means.

(3) Laboratory evidence collected during subsequent laboratory investigations, including field toxicity tests.

The basic question concerning the laboratory work is usually "What is the minimum amount of laboratory work necessary to close the case?" There are two primary considerations:

(1) Can it be shown that one of the major suspects was the cause of the fish kill or must the laboratory investigation start from scratch?

(2) How well must probable cause be established?

However, a third important consideration is that if the on-site investigation was not conducted properly and the proper samples taken and preserved correctly, generally no amount of laboratory investigation can solve the fish kill. The amount of useful laboratory work that can be done is often limited by what was not done during the on-site investigation. Thus, at the time of the on-site investigation the decision must be made whether or not to allow for the possibility of a full scale laboratory investigation.

The speakers at this session will discuss what can be done in the laboratory at the present time and what kind of manpower, equipment, and money are required to do it and some of the things that must be done during the on-site investigation if the laboratory investigation is to be possible and meaningful. Although none of the speakers at this session will discuss legal rules of evidence, it must be remembered that the best laboratory

evidence is of little use in court cases if the court will not allow the introduction of the evidence.

I think two extraneous comments are in order. None of the speakers at this session has had much experience in actual fish kill investigations. However, I think each of the speakers has had experience in areas that relate to laboratory investigations of fish kills. The laboratory methods are basically the same whether the samples are from fish kill investigations or not. Point number two is that none of the speakers are soliciting samples. You can feel free to contact the speakers for advice but if you want samples processed be sure to go through proper channels, etc. None of the speakers is hard up for things to do.

CHEMICAL ANALYSES OF WATER

A - COLLECTION, PRESERVATION, AND ANALYSES OF SAMPLES

INORGANICS by Robert Booth

WHAT

Toxicant Caused Fish Kills

Chemical Analyses of Water

Collection, Preservation, and Analyses of Samples

WHO

Inorganics: Robert Booth

WHEN

Wednesday, Jan. 13, 1971, 10:15 a.m.

WHERE

Skyline Ballroom
The Terrace Hilton
Cincinnati, Ohio

WHY

Fish Kill Investigation Seminar
Jan. 12-14, 1971
Sponsered by EPA, FWQA, Cin., OH
and Ohio Cooperative Fishery Unit,
Ohio State University

CHEMICAL ANALYSES OF WATER: INORGANICS

I. Collection

A. Sample containers

1. Plastic preferred

a. "Hard" plastic

b. Cubitainers (Have source available)

2. Glass is only necessary for taking pictures of collected samples.

B. Amount required

1. Special analyses requiring specific preservation - steps should be taken as separate samples.

a. One liter amounts generally sufficient.

2. For general analyses: 1 gallon

II. Preservation [Slide 1]

A. Icing

B. Freezing

C. Chemical ($HgCl_2$, etc.)

III. Field Tests

A. Visual observations [Slide 2]

1. Suspended matter

2. Oil slicks

3. Bubble patterns

4. Floating objects

5. Turbidity

6. "Unusual" conditions (documentative)

B. Measurements* [Slide 3]

1. Dissolved Oxygen (measure around-the-clock)
2. pH
3. Temperature
4. Conductivity
5. Methyl Orange Alkalinity

*Stress that all equipment must be properly calibrated and checked out against official methods just before going out into field. Also, note use of continuous monitors.

IV. Laboratory Analyses

A. Causative Agents(1) [Slide 4]

1. Acids
2. Ammonia
3. Ferric Hydroxide, ppt.
4. Cyanide
5. Hydrogen Sulfide

B. Industrial Waste Parameters [Slides 5 & 6]

1. Plating
2. Chemical Manufacturing
3. Steel
4. Pulp & Paper

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(1) Swaby, Y. H., 1966, "The Autopsy of Fish Collected in Fish Kills". Research Publication No. 11, The Ontario Water Resources Comm.

V. Skill-Time Rating of Standard Analytical Operations [Slides 7 & 8]

A. Simple Instrumental

B. Simple Volumetric

C. Simple Gravimetric

D. Simple Colorimetric

E. Complex, Volumetric or Colorimetric

F. Special Instrumental

VI. Desirable Data

A. Industrial waste inventory

B. Up-dated references to specific parameters, especially those involved in water quality standards and effluent standards.

C. Flow data

CHEMICAL ANALYSES OF WATER

B - INTERPRETATION & USE OF DATA

by

Dr. William Brungs

Interpretation and Use of Chemical Data

William A. Brungs, Ph.D.

Abstract

The use of chemical data to provide answers as to the cause of biological results involves an awareness of basic principles of fish toxicology. The determination of a concentration of a material that is equal to or less than that stated to be lethal to fish in some reference is not conclusive evidence that the material caused the observed fish kill. Many environmental variables such as temperature, pH, calcium, dissolved oxygen, species of fish, age of fish, and many more, cause the toxic actions of many materials to be variable, sometimes over one or two orders of magnitude. In addition most results of toxicity studies involve exposures to continuous concentrations; whereas the water samples may reflect a concentration that existed for a short time period.

CHEMICAL ANALYSES OF TISSUE

A - COLLECTION, PRESERVATION, AND ANALYSES OF SAMPLES

INORGANICS by Charles E. Stephan

FISH KILL INVESTIGATION SEMINAR

Session III. Toxicant Caused Fish Kills

Part 3. Chemical Analysis of Tissue

A. Collection, Preservation and Analysis of Samples: Inorganics

Charles E. Stephan

The term "inorganics" should properly cover a lot of materials but in practice fish kills caused by inorganic toxicants are probably generally caused by heavy metals, acids, ammonia, cyanide, and/or sulfide. In terms of tissue analysis, as far as I know the only work that has been done with inorganics that might be useful in fish kill investigations involves heavy metals and even here the amount of useful information available is small. At present there are about twenty-six metals that are considered potentially important toxic pollutants. There are undoubtedly adequate methods available for measuring each one of these in any tissue. Unfortunately there is a lot of conflicting evidence, many methods are specific rather than general, and often the equipment and/or manpower requirements are excessive. The state of the art is not in very good shape, although a little concentrated effort in the right direction could probably produce some real advances.

The best routine method for quantifying metals at the present time is atomic absorption spectrophotometry and the instrumentation costs on the order of $10,000. With proper sample preparation AAS can measure metals in tissue and in water. A major drawback is that the metals are generally done individually so that twenty-six metals require twenty-six separate determinations. Other methods are available for measuring some groups of metals simultaneously. Individual measurements are not too bad if you are only looking at one or two suspects, but for the screening of twenty-six metals, individuals measurements are almost out of the question.

We can get a picture of the situation by first considering atomic absorption analysis of a series of ten water samples from a fish kill on-site investigation. For simplification we will assume that the machine will reach the minimum necessary detectable level for each of the 26 metals, but of course this is not the case at the present time. One of the major advantages of AAS is that most aqueous samples can be run

by direct analysis with no sample preparation except acidification. So for each metal one merely aspirates a sample, adjusts the sensitivity of the machine if necessary and aspirates an appropriate standard. In order to switch from one metal to another, the instrument must be readjusted. With the better instruments the samples and standards can be run automatically with the machine calculating and printing the concentration of the metal in each sample. Such an instrument costs about $16,000. However, the instrument must be manually adjusted for each individual metal by the operator. There is available a flame emission scanning attachment for one or more AAS instruments which may allow screening of samples for many metals simultaneously, but this technique has not been evaluated and it will not be at all useful for quite a few of the 26 metals considered to be potential problems.

For tissue analysis there is the additional problem of sample preparation. Obviously the advantages of simultaneous quantification are negated if simultaneous sample preparation is not possible. Alternatively, the full advantages of simultaneous sample preparation cannot be realized if simultaneous quantification is not possible. There is some hope for development of methods that will allow the simultaneous quantification of many metals in tissue without any sample preparation.

Concerning preservation, the best method for preserving tissue samples for metal analysis is freezing. The use of preserving solutions is prohibited. Individual samples should be frozen in separate plastic bags and permanently labelled. Concerning sample preparation, there is no one technique that can be used in all cases. Preparation of tissue samples for atomic absorption is generally done either by wet acid digestion, by high temperature dry ashing, or by low temperature dry ashing. No one technique is adequate for all metals in all tissues, and there is conflicting evidence and opinions on methods that can and should be used. I feel that the diversity and confusion in the literature indicates that no good routine methods are available at the present time.

I know all of this is not good news, but I think this is the fairest possible clear, concise report on the state of the art. There are some

bright spots, but there is not even general agreement as to what the bright spots are. This only applies to the measurement of metals in tissue. The information on the measurement of other inorganic toxicants in tissue for fish kill investigation is even more discouraging. Ammonia, hydrogen cyanide, and hydrogen sulfide are volatile and are degradable, so the preservation of samples is nearly impossible.

CHEMICAL ANALYSES OF TISSUE

B - INTERPRETATION & USE OF DATA

by

Charles E. Stephan

FISH KILL INVESTIGATION SEMINAR

Session III. Toxicant Caused Fish Kills

Part 3. Chemical Analysis of Tissue

B. Interpretation and Use of Data

In this session we are generally talking about proving the cause of a fish kill, not just collecting circumstantial evidence. In this regard the basic point I want to make is that it is not enough to find a toxicant in a fish. In order to prove that a toxicant caused a fish kill, one must prove that there was enough of the toxicant in the dead fish. As far as I know, the only way to do this is to find enough of the toxicant in the right tissue of the dead fish. What constitutes enough varies from species to species and even from population to population for one species. What constitutes the right tissue must be determined for each individual toxicant, and hopefully will not vary from one species of fish to another. Although blood is the right tissue for several pesticides, the right tissue is different for copper, cadmium, and zinc. For cadmium the gill is the right tissue, but for zinc one must look at both gill and opercular bone, and neither of these is right for copper. The only way to determine the right tissue for a specific toxicant is to conduct toxicity tests and measure the concentrations of the toxicant in various tissues from both live and dead fish from both long and short exposures and thereby prove the existence of a critical level in a critical tissue. Once this has been done, the next step is to show that this tissue is the right tissue for that toxicant in other species of fish.

The concept of a critical level in a critical tissue assumes that all of the fish of a given population killed by a toxicant under a given set of conditions will have a concentration of the toxicant in the critical tissue higher than the critical level and all of the fish not killed by the toxicant will have a concentration lower than the critical level. The concept of a critical level in a critical tissue is proposed only as a diagnostic tool and is not meant to imply anything about the site or mode of action, etc. The validity of this concept can be checked experimentally in a straightforward manner, although it does require quite a

bit of work. So far the concept apparently has been shown to be valid for several pesticides, cadmium and zinc, although not too many species of fish have been worked with yet. Obviously because of biological variation, it is very unlikely that the separation of live and dead fish by the critical level will be one hundred per cent accurate, but so far the separation seems to be about eighty to ninety per cent accurate.

Originally it was thought that it might be possible to establish a critical level for a given toxicant in a give species and that this level could be used across the country for that species. However, the existence of resistant fish has pretty well destroyed that idea. But this has not necessarily destroyed the practical usefulness of the concept of a critical level in a critical tissue, and I believe that it might be possible to apply the concept in a more powerful way than was first imagined.

The present proposal is that during the on-site investigation, three kinds of samples should be collected for tissue analyses. The first kind of sample is the standard up-stream live unexposed fish. The second consists of the dead fish. The third and equally important kind of sample consists of live exposed fish. The dead fish should be dead, not nearly dead fish and the live fish should be live, unaffected fish. The distinction between slightly affected and severly affected is often difficult to make, is at best a subjective decision, and merely complicates the problem of identifying a critical level in a critical tissue. For each species to be examined, about twenty fish should be collected for each of the three kinds of samples. Preferably all fish of one species should be about the same size.

Actually the crux of the matter lies in the collection of the unaffected live exposed fish and the dead fish. Collecting dead fish is usually not too much of a problem. Collecting unaffected live exposed fish may be a problem. In order to do this, one will normally have to go "downstream" until live fish can be found. Of course it is important that there be no question as to whether or not these fish were exposed to the toxicant; this should not be too difficult in a stream but may be in a lake. And since the on-site investigation is normally done some time

after the fish kill has occurred, there will be no way to tell whether the fish were affected by the toxicant or not. Although theoretically it is best to have unaffected live exposed fish, in practice one must do the best he can. However, on-site the investigator should have a clear understanding of what he is after and why.

By using the appropriate samples and analytical techniques in the laboratory investigation, one can attempt to determine if there appears to be a critical level of any substance in any tissue for the fish involved in the fish kill. By using such techniques, it might be possible to overcome complications from hypersensitive fish due to other stresses, resistant fish, and prior exposure. In effect, the fish kill is being treated as a field toxicity test, and the fish from the fish kill are being used to determine whether or not a critical level existed in a critical tissue. If general screening techniques are available, the method can even be used with unknown toxicants. If an unknown toxicant is suspected, once it has been identified, laboratory toxicity tests can determine if the same critical tissue were found for that toxicant with the same or other species of fish.

As far as we know, this is probably the only kind of approach that can be used at the present time to try to prove the cause of a fish kill from tissue analyses. But it cannot be used unless enough unaffected live exposed fish and enough dead fish of the same species are collected and preserved correctly during the on-site investigation.

Charles E. Stephan

HISTOPATHOLOGY OF FISH TISSUE

by

James H. Tucker

Histopathology of Fish Tissues

Present knowledge of toxicant induced histopathologic changes in fish tissues does not permit, in most instances, delineation of unique morphological responses to a specific toxicant. At acute lethal concentrations ample information does exist to permit grouping of certain toxicants according to similar lesions produced. Consequentially, the primary value of histopathology in a Fish Kill Investigation Program is the exclusion or inclusion of groups of toxicants as suspect in a fish kill and not in the positive identification of the specific killing agent.

Equally important is the use of histopathologic examinations of fish tissues in identifying fish kills resulting from natural causes, e.g. bacterial and other parasitic diseases.

A coordinated fish kill screening program utilizing histopathological and parasitological examinations in conjunction with a comprehensive field report may save considerable time and money by eliminating much of the speculation usually associated with causal relationships in fish kills.

SUMMARY and DISCUSSION

of

SESSION III

by

Charles E. Stephan

FISH KILL INVESTIGATION SEMINAR

Session III. Toxicant Caused Fish Kills

Part 5. Summary

Charles E. Stephan

I think a few important conclusions can be drawn:

(1) What can be accomplished in the laboratory investigation is too often limited by what was not done during the on-site investigation:
   (a) The right samples must be taken.
   (b) The samples must be preserved correctly.

(2) It is a lot easier to answer the question "Did this toxicant cause the fish kill?" than it is to answer the question "What caused the fish kill?"

(3) It is a lot easier to collect circumstantial evidence than it is to prove the cause of the fish kill.

(4) There is an urgent need for research into methods for use in the investigation of fish kills:
   (a) What samples should be collected.
   (b) How the samples should be preserved.
   (c) How to analyze water and tissue samples, especially the development of screening techniques for groups of toxicants.
   (d) Correlating the results of toxicity tests with histological and chemical analyses of tissue using a variety of toxicants and a variety of species under a variety of conditions.

(5) There is an urgent need for the establishment of something like a national fish kill investigation center which could do the research just mentioned and could do extensive laboratory investigation of fish kills. A comprehensive laboratory investigation will usually require a coordinated effort involvi.. trained manpower and expensive equipment. It is unlikely that such a center will ever be available on less than a national basis. To be most effective, such a center would have to be both a research and a service facility and would have to perform toxicity tests. Individual states and/or regions should be able to provide the personnel for teams to conduct the on-site investigations, but a national center could provide training and guidance for such teams.

IV. GENERAL FISH KILL INVESTIGATIONS

Moderator: Stephen Taub

FIELD INVESTIGATIONS & TECHNIQUES

by

Richard Francis

Topic: Field Investigations and Techniques -
Pollution Caused Fish Kills

Presented by Richard Francis, Assistant Law Enforcement Supervisor at the January 12-14, 1971 Fish Kill Investigation Seminar sponsored by Environmental Protection Agency and Ohio Cooperative Fishery Unit of the Ohio State University

I. Introduction

The Ohio Division of Wildlife is charged with the responsibility of protecting wild animals and holds them in trust for the benefit of all the people of Ohio. The division, therefore, has always been involved in the investigation of pollution caused fish kills. Prior to 1964 the reasons for conducting such investigations were many, but primarily they involved fisheries management. Field investigations were conducted with this in mind and were therefore, conducted primarily by fisheries personnel. Information collected during the field investigation was turned over to the Ohio Department of Health, Division of Sanitary Engineering for corrective action.

An effort was also made to collect damages for the loss to the people of Ohio by submitting the evidence collected to the Attorney General's Office.

In 1964 Division of Wildlife administrators inquired of the Assistant Attorney General assigned to the division, as to why evidence collected on certain cases was not sufficient to substantiate a cause of action in court and why such evidence was not being used in corrective actions against the responsible parties.

The Assistant Attorney General took several investigation case file folders to personnel in the Law Enforcement Section for review and analysis.

The answer to the questions were obvious. The cases were lost at the scene of the offense. Law Enforcement officers are aware that accurate and thorough investigation is the foundation of successful prosecution. It has often been said that criminal cases are won or lost at the scene of the crime. But not always are law enforcement

officers aware that something more than sound investigation is required in order to support their case. Court dockets reveal that countless cases have been lost because some important bit of evidence, laboriously collected and relied upon by the officer to establish the case, has been thrown out because it did not satisfy the rules of evidence. Evidence must be obtained which will be admissible in court. The investigator must understand the fundamental rules governing the admission and rejection of evidence.

The Division of Wildlife after analyzing their pollution investigation program assigned the responsibility for conducting such investigations to the law enforcement section, who worked very closely with the Fish Management Section, Fish and Game Research Section, Assistant Attorney General, and the Ohio Department of Health laboratory to establish proper procedures to assure that evidence was sufficient to support any type legal action desired whether it was a civil suit for damages or an arrest for violation of a criminal statute.

The Division's legal section was quite fortunate when it came to establishing the new procedures.

First: There always was a little bit of Dick Tracey in the district fisheries biologists, some of which had been working on the lakes and streams in their respective districts for fifteen or more years. Their knowledge of past fish kills and the suspected source of pollution was and is most valuable. They are experts in the field of pollution caused fish kill.

Second: The Division had a good working relationship with some of the Ohio Department of Health chemists and laboratory technicians who were truly interested in wildlife conservation and pollution control.

Third: The Assistant Attorney General assigned to the Division was housed in the Law Enforcement Section Offices.

Finally: The Division Law Enforcement program provided for resident game protectors in each county.

In each of the Wildlife District Offices we have four Wildlife Agents and a District Law Enforcement Supervisor. The Wildlife Agents are comparable to detectives on a police force and work only on investigations. The Game Protector in a county would be comparable to a patrolman on a beat and would be expected to know every nook and cranny of his assigned area.

II Preparation for Field Investigations

Standard equipment to be taken on all investigations:

A. Thermometer
B. Dissolved Oxygen sampler - Any type that meets standards or Chemical Kit.
C. D.O. Bottle or Quart Mason Jars.
D. p^H test meter or Chemical Kit.
E. One quart and one gallon sample bottles.
F. Camera.
G. Compass
H. Maps - preferably U. S. Geological Survey Maps, and official county engineer maps.
I. Flourescent dye - Tracing Powder.
J. Preservatives - a - Cyanides - pallets of sodium hydroxide.
b - Phenols - copper sulfate crystals.
K. Pencils and note paper - tablet, ruler.
L. Ice Chest - plastic bags.
M. Containers for preserving water samples, soil samples, wild animal specimens.
N. Metal Tape Measure - 50' or 100'.
O. Necessary field report forms - receipts, tags, labels, etc.
P. Procedure and Reference Manual.

Note: It is also desirable to have a tape recorder for recording observations, orders, radio messages, field data, etc.

Division of Wildlife Law Enforcement Agents have kits issued to them which contain the items listed as well as additional equipment for making casts and moulds, disecting kit, rubber gloves, gas mask, etc.

III Making the Field Investigations

I would like to report a fish kill:

This is the type call or report our District Office or Game Protector might receive. All systems are go. Wildlife killing pollution investigations have priority over all other work.

Approximately 60 to 80 percent of the evidence collected during the investigation is going to be obtained as a result of the interviewing or interrogation of witnesses, informants, suspects or other parties. Therefore, you might just as well start off right with that first call. Obtain the answer: (who, what, where, how, why and when) Get the name, address and telephone number of the complainant. You may have to contact him later. Get the exact location of the reported kill, when it was discovered, what did the stream look like, was there any odor noticeable, etc.

The assigned Game Protector immediately goes to the scene and completes the initial investigation and fills out the necessary field report and reports his findings to District Supervisor. Information ascertained on the initial report includes:

1. Name and location of waters effected.
2. Exact time of arrival at the scene.
3. Approximate number of dead or dying wild animals.
4. a. Collect water samples at the scene of dead or dying animals.
   b. Collect water samples of the suspected pollutant before entering water.
   c. Collect water samples where suspected pollutant entered and mixed with water.
   d. Collect water sample upstream from where suspected pollutant entered water.
   e. Collect water samples downstream from where dead animals are located.
5. Collect samples of dead wild animals.
6. Attempt to determine extent of kill, extent of pollution.
7. Record water temperature and air temperature at every location water samples were collected.
8. Attempt to locate suspected source of pollution, suspected polluting substance, how it entered, other pertinent observations.
9. Prepare a map of the situation showing land marks, direction of north, direction of stream flow, water sample locations, dead or dying fish found.

Proper communications between the field investigators, the District Office and the Columbus Law Enforcement Headquarters is of the utmost importance in the Division's pollution investigative program. All of the field men have radio equipped automobiles. The District Offices, as well as the Columbus Headquarters are base radio stations.

While the Game Protector is completing his initial investigation, the District Supervisor is alerting the District Law Enforcement Supervisor, a Wildlife Enforcement Agent, and the District Fisheries Biologists. The District Office also relays facts and receives instructions from the Columbus Law Enforcement Headquarters.

The District Supervisor receives information from the Game Protector conducting the initial investigation. Information received will indicate suspected source and type of pollution, water area effected, value of wild animals killed (over $25.00 in value, under $25.00 in value - or no kill), and an indication as to the accessability of the area effected - a boat may be required, etc.

The Columbus Law Enforcement Section will coordinate directly with the Ohio Department of Health and other agencies that might have knowledge of discharges from know industries, municipalities, or other potential sources of pollution.

The Ohio Department of Health through its Water Pollution Control Board is charged with the responsibility for pollution abatement in Ohio and therefore, should be aware of any pollution substances being discharged into Ohio's waters.

The instance of pollution is assessed to determine if a full scale investigation is warranted. If the value of the wild animals killed is $25.00 or over, or the pollution is due to acts by a habitual offender, or the pollution is due to a possible stream litter violation, a full scale investigation is directed.

IV Full Scale Investigation Assigned

District Law Enforcement Supervisor or assigned agent goes to the scene and takes charge of the investigation. He maintains a work record on the entire investigation showing the date and time of each occurrence. He maintains a list of principals and witnesses - full names, addresses and phone numbers are recorded.

Water samples collected by the Game Protector are examined to make sure they are labeled, numbered, and packed properly. Additional samples are collected if required. If preservatives are or were used, duplicate unpreserved samples are collected.

The Division's pollution investigation program is designed in such a way that if the nature of the investigation can be conducted by a minimum of two men the game protector and law enforcement agent will conduct the entire investigation. If the nature of the investigation requires additional man power or experts, the biological work will be conducted by a fisheries biologist and the investigation work will be conducted by the Law Enforcement Agent. In the larger cases several Law Enforcement Agents, Fisheries Biologists and Game Protectors will be utilized.

The investigation is photographed, especially sources of pollution, dead fish, sample sites, etc.

Wate- field tests are conducted at each site a water sample was collected. Other field tests may be made if desired. The field tests conducted are p^h, D. O. water and air temperature, trasnparency, water color, and odors. All are recorded. Observations of the condition of the stream is recorded for each test site. Comments on weather conditions, conditions found upstream, downstream and at the pollution source, stream flow, vegetation, animals collected, test fish used, kill count are recorded.

The Law Enforcement Agent together with any experts he may require go to the suspected source of pollution. Individuals in charge are contacted. They are advised of the kill and are questioned regarding the situation. In plant or facility inspections are requested and made. The Law Enforcement Agent is ever on the look out for signs of spills, drains, tiles, that may have a bearing on the case. In many cases flourscent dye may be used to trace suspects drainage system or farm field tiles. Where ever possible, written statements are obtained.

Probable witnesses that may provide information as to what happened are contacted. These may include area residents, school bus drivers, mailmen, fishermen, employees of the suspect, etc. Again, written statements are obtained where ever possible.

All kinds and types of supporting evidence such as data from sewage treatment plants, weather stations, factories and others known to be directly effected or concerned with the problem are collected.

Personnel are directed in making a count of the dead wild animals in accordance with the procedure given in In-Service Document #21.

The field investigators contact the Columbus Law Enforcement Section regarding tests to be made on the collected samples.

The Law Enforcement Section will advise or coordinate with the Health Department or other knowledgeable people regarding the tests to be conducted on water samples or dead wild animals collected.

Evidence examination forms which provide the receiving laboratory with a brief description of the case, the descriptions of evidence submitted and specific examination requested, and which also includes receipts for the evidence submitted shall accompany all samples to be tested.

All water samples are refrigerated and delivered to the laboratory for analysis as soon as possible after collection. Marked evidence is secured so that it will not deteriorate.

When chromatographic analysis of pesticides, etc. are required, one gallon samples are provided. Where ever possible a sample of the material to be tested for is provided to the laboratory. This sample is usually provided by the suspected pollutor or is collected at the scene of the offense.

IV Field Investigation Completed

The investigators report is typed and approved. Maps are prepared showing location of the water sampling stations, field test locations, the fish kill and count stations. Situation maps clearly showing source, direction of stream flow, direction of north, distance to nearest town, land marks such as bridges, roads, etc., are made.

The total counted kill or the total projected kill is calculated from data collected and the value of the dead wild animals is tabulated.

All field investigation costs are calculated. Hours, miles, and other expenses for each man working on the case.

Data received from laboratories conducting tests is analyzed. Fisheries biologists and pollution specialists prepare interpretation reports on biological and chemical data. The District Law Enforcement Supervisor reviews the entire case file folder, and recommends action. He then forwards to District Supervisor who also reviews and makes recommendations.

The case file is submitted to the Columbus Law Enforcement Section, where the case is reviewed by the pollution specialist, the Law Enforcement Supervisor and the Assistant Attorney General.

If evidence is sufficient to collect damage in court a claim letter is sent to the responsible party and the case is submitted to the Assistant Attorney General for action.

If an arrest is in order for stream litter the Law Enforcement Agent conducting the investigation will process the case through court.

VI Summary

Nothing can be assumed in conducting an investigation. Everything must be verified. All evidence collected must be marked and preserved. Receipts must be made each time evidence is transferred from one to another. Evidence must be safe guarded, where possible evidence should not be altered or changed. Original field notes should be maintained by the investigator. The chain of evidence must be safe guarded. Written statements should be obtained wherever possible.

Evidence collected during a pollution investigation may very well be used in a criminal case, a tort action or a hearing before a pollution control board. It is possible that evidence from one investigation would be used in all three of these examples.

Whenever you are conducting an investigation - think -

What am I trying to prove?

How am I going to prove it?

LIMNOLOGICAL CONSIDERATIONS

by

Lowell Keup

FACTORS IN

FISH KILL INVESTIGATIONS*

INTRODUCTION

This paper will give examples of various environmental factors that should be borne in mind when investigating fish kills. Frequently investigators arrive on site long after a kill occurred, and are confronted with long-dead and decomposed carcasses. In this situation there is little that can be done to obtain pertinent facts toward piecing together a puzzle to provide a picture of what happened or obtain information to determine and prove the cause. Thus, probably the single most important factor is to place investigators on site as rapidly as possible. The ideal is to have men on site while fish are dying. So, agencies charged to investigate fish kills must have very rapid alert systems and contingency plans to put teams on site as rapidly as possible.

Teams are desirable rather than a single individual. The reasons for this are many fold but probably the most important two are:

1. Two heads are better than one in figuring the intricate things that may be involved. In fact, by increasing the size of teams, their ability to

*A complete report can be obtained by writing Mr. Lowell Keup, Division of Field Investigations, 5555 Ridge Road, Cincinnati, Ohio 45213.

solve problems increases more than arithmetically, and is probably more geometric.

2. Investigations of fish kills involve several areas of expertise. Local game wardens are intimately aware of possible sources of pollutants, watershed characteristics, and are usually trained in procedures for gathering evidence that will be acceptable in court if prosecution results. Biologists should provide precise identifications of fish killed, information on what may be causing a kill from fish reactions, and are best suited for the collection of fishes or tissues for any autopsy work that may be required. Chemists will be needed for their professional capability to perform analyses for water and tissue contaminants. Teams should be trained and have available, or be directed by, trained and experienced limnologists or oceanographers (ecologists) who have the ability to piece together and evaluate the facts. Sanitary engineers may not be required on site, but definitely are usually required as consultants to perform certain studies in an investigation.

I will now discuss some factors that this team should be aware of in planning and executing their activities.

INDIRECT & SECONDARY FISH KILLS

by

Nelson Thomas

INDIRECT AND SECONDARY FISH KILLS*

INTRODUCTION

Fish kills that do not result from a direct toxic or severe change in the chemical composition of the water are the hardest to detect and usually go unsolved. Often it is only when environmental studies are conducted that the cause of an indirect fish kill becomes evident. Usually an indirect or secondary fish kill is gradual because the fish avoid the specific reach of water and there is little recruitment except through migration. Litigation involving an indirect or secondary fish kill almost never ends up in court because the evidence is too circumstantial or the kill is listed as natural.

DEFINITION OF AN INDIRECT OR SECONDARY FISH KILL

A fish kill in which the fish are not killed outright by a mechanical means, poisoned by a toxic substance or severe environmental changes that produce immediate death would be either natural or indirect. Included in the category of indirect fish kills would be deaths resulting from fish being in a starved condition, thus making them more susceptible to pollutants. An example of a secondary fish kill would be damage to a fish population resulting from a pollutant altering the ecology of a body of water which would in turn have an adverse effect on the fish population.

In this paper we will mainly discuss conditions that indirectly kill fish and just touch upon conditions where the environment is made hostile to fish communities.

*A more complete report can be obtained by writing Mr. Nelson Thomas, Division of Field Investigations, 5555 Ridge Avenue, Cincinnati, Ohio 45213

V. CASE HISTORIES

Moderator: Ronald Preston

TVA MERCURY KILL

by

Thomas Wojtalik

TVA Mercury Kill*

A kill of more than 500,000 fish (primarily mature gizzard shad) occurred during the interval July 9-13, 1968. The cause was determined to be a toxic mercury compound accidently introduced into the reservoir from discarded 55-gallon metal drums. Multiple potential toxic agents that individually or in combination could cause fish mortality were found in the reservoir; however, none of these agents produced the unique series of symptoms observed. All common kill inducing conditions were eliminated as causes before the identified toxicant was located, identified, and isolated. A series of reconstituted environmental and physical or chemical conditions were developed, and the kill and its symptoms were reproduced in the laboratory.

*Abstracted from FISH-KILL IN BOONE RESERVOIR, July 9-13, 1968, TVA Division of Health and Safety, Water Quality Branch, December 1968

INDIANA CYANIDE SPILL

by

Samuel Moore

INDIANA CYANIDE SPILL*

About 9:30 p.m. on January 1, 1968, a train wreck involving two trains and about 30 cars occurred at Dunreith, Indiana. Dunreith is a small town of 236 persons located 40 miles east of Indianapolis on U. S. 40.

Five tank cars carrying chemicals, two acetone cyanohydrin, one vinyl chloride, one ethlene oxide, and one methyl methacrylate, were involved in the wreck. Each tank car held approximately 20,000 gallons. Railroad officials believe the wreck was caused by a broken rail at the crossing of the Pennsylvania Railroad and Norfolk & Western Railroad on the east side of Dunreith.

Immediately after the wreck, Dr. A. C. Offutt, State Health Commissioner, was contacted by the Indiana State Police and a representative of the Indiana State Board of Health and Indiana Stream Pollution Control Board was on the scene within a few hours. A second representative was stationed temporarily at the Indiana State Police control center in Indianapolis.

The purpose of this paper is to acquaint you with the emergency activities conducted by representatives of the Indiana State Board of Health and Indiana Stream Pollution Control Board during the disaster.

*Complete report, "Cyanide Pollution and Emergency Duty Train Wreck, Dunreith, Indiana, January 1968," can be obtained by writing Samuel L. Moore or Stephen R. Kin, Indiana State Board of Health, Indianapolis, Indiana.

EPA, WQO Contingency Plan
Richard M. Jones, Chief
Special Regulatory Activities

The establishment of the ten Standard Federal Regions has changed the responsibility for contingency planning in the Ohio Basin Region. The Ohio Basin Region was based on drainage to the Ohio River; the Region now has been divided along State lines. The Regions now having responsibility for the Ohio River drainage are Region II, New York City; Region III, Philadelphia; Region IV, Atlanta; and Region V, Chicago. The areas of these Regions are shown in the Ohio Basin Regional Oil & Hazardous Materials Pollution Contingency Plan.

The Water Quality Offices at Wheeling, West Virginia, in Region III, and Evansville, Indiana, in Region IV, will have contingency responsibility for the Ohio River area within their new Regions and in other areas within other Regions to be agreed upon. These areas of responsibility will be described in a new contingency plan to be prepared by the new Regions.

Each Region and Water Quality Offices at Wheeling and Evansville have a person assigned the responsibility for contingency responses. These individuals have the facilities of these offices available for use in the event of a spill or fish kill. For proper response to a fish kill, prompt notification is required. Coast Guard and Environmental Protection Agency On-scene Commanders to be notified immediately of a spill or fish kill are listed in the Contingency Plan. Also, listed are the Corps of Engineers Division and District personnel, and other Federal and State Agency personnel to be informed of spill emergencies. On the Ohio and Cumberland

Rivers are mutual aid groups. These groups (12 in number) have equipment, supplies, and trained personnel for the containment and clean-up of oil spills and to assist in other emergencies. The contacts and supplies are listed in the Contingency Plan. If necessary, all these facilities and personnel of all agencies in the Contingency Plan are available in emergency situations.

Laws being used to enforce water pollution controls are the Refuse Act of 1899, Water Quality Improvement Act of 1970, and various State statutes. The Federal Government is required by the Water Quality Improvement Act of 1970 to be present at spill and fish kill incidents to observe, advise, assist, or take control, if available facilities are unable to handle the situation. The primary responsibilities for investigation of incidents belong to the local and State governments. The polluter is primarily responsible for containment and clean-up. The polluter must work within the guidelines set forth by local, State, and Federal governments.

Recently in Ohio the use of the Contingency Plan and the cooperation of State and Federal agencies resulted in prosecution of a company for the causing of a fish kill of over 2 million fish. This indicates that the job of responding to and cleaning up an ecological incident can be done when teamwork and proper procedures are used.

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